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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)

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1 OF 5

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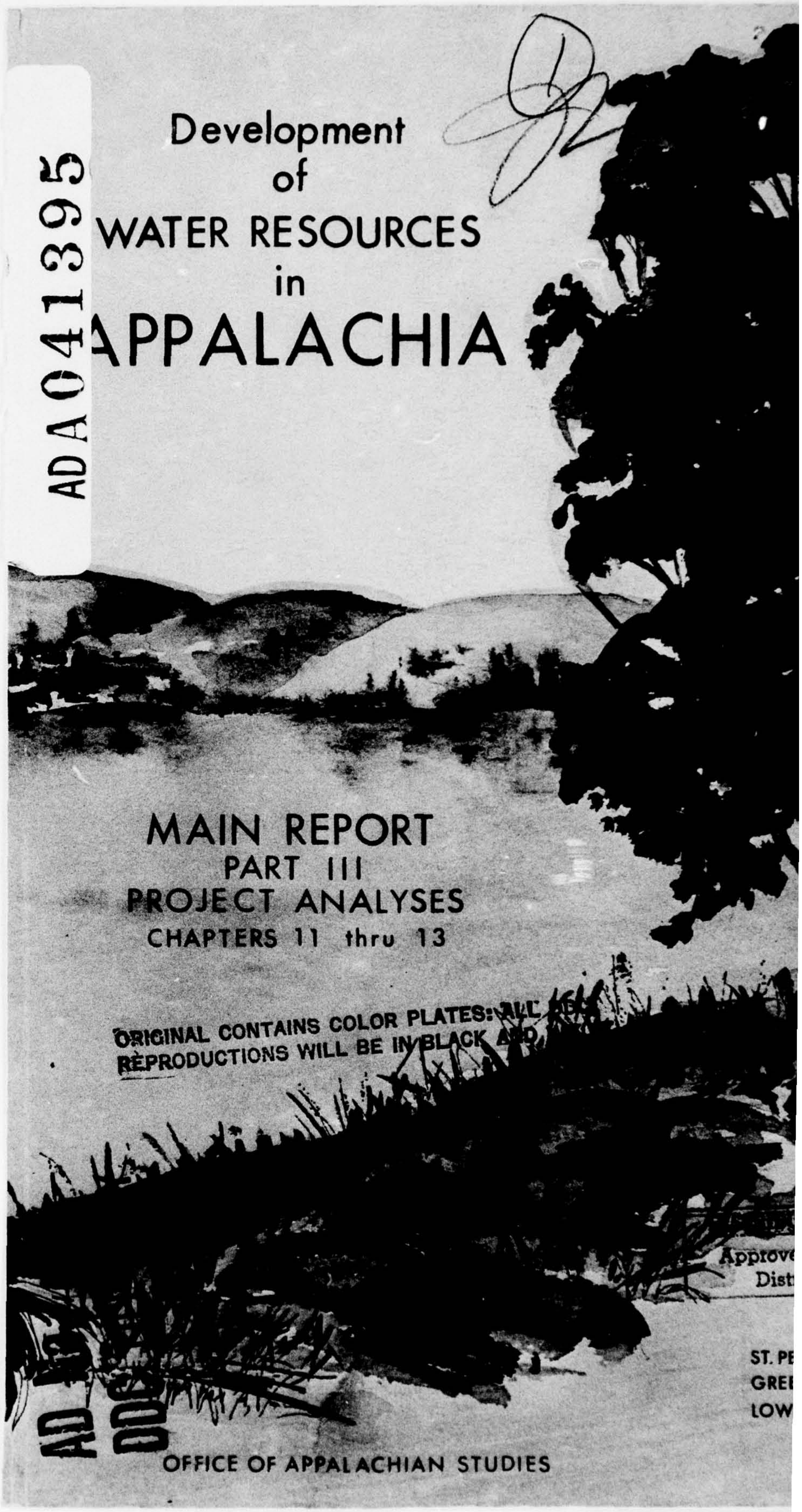
Development of WATER RESOURCES in APPALACHIA



MAIN REPORT
PART III
PROJECT ANALYSES
CHAPTERS 11 thru 13

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LOW

OFFICE OF APPALACHIAN STUDIES

CORPS OF ENGINEERS

U. S. ARMY

DEPARTMENT OF THE ARMY
OFFICE OF APPALACHIAN STUDIES. CORPS OF ENGINEERS
P. O. BOX 1159
CINCINNATI. OHIO 45201

TO: THE READER

This volume ~~(Number 9)~~ is one of six that comprise Part III, "Project Analyses", to the Main Report for Development of Water Resources in Appalachia. The volume contains three of the 20 chapters that make up Part III.

Each chapter generally contains information on how the project was formulated and designed; its estimated costs; the type and value of benefits expected; and the indices of performance. Also included, as appropriate, is information on sharing of project costs among Federal and non-Federal interests, coordination carried out during the planning process, and conclusions reached. See Part II, Sub-regional Plans, for the economic impact of each project on the region.

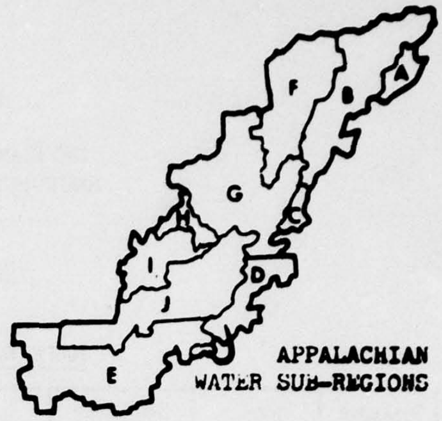
Chapter 11, St. Petersburg Reservoir Project, prepared by the U.S. Army Engineer District, Pittsburgh, presents a plan for a multiple purpose reservoir development (which includes hydroelectric power) on the Clarion River, about 80 miles north of Pittsburgh, Pennsylvania. Chapters 12 and 13 were prepared by the U.S. Army Engineer District, Huntington. Chapter 12, Greenbrier Reservoirs, will not be published for reasons outlined on the two pages bound after Chapter 11 of this Volume. Chapter 13, Lower Knox Reservoir (Tug Fork Basin), which is located in eastern Kentucky, southwestern West Virginia, and has two small segments in northwestern Virginia, presents a plan for a reservoir which would provide services needed to aid in satisfying needs of the area and thereby encourage development of the Tug Fork Basin.

The Summary Report (Part I, Volume 1) should be consulted for recommendations made as a result of the information presented in this volume. A volume index for the Main Report and its nine supporting Appendices is included on the next two pages for your convenience.

JOHN C. H. LEE, JR.
Colonel, Corps of Engineers
Director

REPORT
For
DEVELOPMENT OF WATER
RESOURCES IN APPALACHIA

VOLUME INDEX



APPALACHIAN WATER SUB-REGIONS

MAIN REPORT

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For
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21	F	Recreation and Aesthetics
22	G	Fish and Wildlife Resources
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WATER RESOURCES IN APPALACHIA.

Main Report.

Part III. Volume 9.

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VOLUME 9

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12. GREENBRIER RESERVOIRS (Not Printed)
13. LOWER KNOX RESERVOIR PROJECT (TUG FORK BASIN), KENTUCKY, VIRGINIA AND WEST VIRGINIA

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Office of Appalachian Studies

Corps of Engineers

November 1969

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REPORT FOR DEVELOPMENT
OF
WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSES

CHAPTER 11

ST. PETERSBURG RESERVOIR PROJECT

CLARION RIVER BASIN

PENNSYLVANIA

Office of Appalachian Studies

Corps of Engineers

October, 1969

PART III

PROJECT ANALYSES

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PART III

PROJECT ANALYSIS

CHAPTER 11 - ST. PETERSBURG RESERVOIR

SECTION I - SUMMARY

1. DESCRIPTION

The site of the proposed multiple purpose St. Petersburg Reservoir is located on the Clarion River in the unglaciated Allegheny Plateau of Northwestern Pennsylvania, in Clarion, Forest and Jefferson Counties, about 80 miles north of Pittsburgh and about 5 miles above the junction of the Clarion River with the Allegheny River. The Clarion River Basin and the location of the proposed St. Petersburg Reservoir are shown on Figure 11-1.

The reservoir (see Exhibit 11-1 for General Reservoir Area Conditions) would become a part of the ecological system of the Clarion River Basin which averages about 75 miles in length and about 25 miles in width. The basin contains 1,249 square miles and comprises 10.6 percent of the total drainage area of the Allegheny Basin. The River rises in Elk County, to the east of the reservoir site, and follows a winding course in a generally southwesterly direction for about 150 miles. Elevations vary from ridges of about 2,300 feet in the headwater portion of the basin to streambed of 850 feet at the river mouth. The natural river channel cut into rock is now stable and well defined.

An existing hydroelectric power project (Exhibit 11-2) which is owned and operated by the Pennsylvania Electric Company about 25 miles above the river mouth, has submerged the natural river upstream for about 12 miles since 1920. Generally, the reach of the river and its tributaries between the head of Piney Reservoir and Ridgway, a distance of about 49 miles, while no longer wilderness, is only partly developed and much of the area adjacent to the river lies in National forest or State forests, game and park land. (See Exhibits 11-3 and 11-4.) An existing multiple-purpose reservoir for flood control and low-flow augmentation for a part of the upper Clarion River Basin is located on the East Branch of the Clarion River about 16 miles above Ridgway and 8 miles above Johnsonburg. The East Branch Reservoir controls a drainage area of 72.4 square miles.

The multiple purposes of the plan of proposed improvements are: flood control; water quality control; water supply; hydroelectric power, recreation, conservation, fish and wildlife enhancement, and other environmental quality improvements; and economic development. Major physical and developmental features briefly are: (See Figure 11-2.)

a. Main Dam - A concrete gravity type structure, 1.830 feet long, 288.5 feet high with control works, including a 315-foot wide gated concrete spillway. The reservoir would have a total storage capacity of 981 thousand acre-feet to impound 14.78 inches of runoff from 1,245 square miles of upstream drainage area.

b. Reregulating Dam - A concrete reregulating dam located about 4 miles downstream from the main dam, 350 feet long, 38 feet high, including a 300 foot long uncontrolled spillway, and four gated 5'-6" x 10' sluices for controlling releases for water quality.

c. Environmental quality improvements, including General Outdoor Recreation, Conservation, and Fish and Wildlife Enhancement - Nine public general recreation areas would be developed with public use facilities and with adequate circulation and access. These facilities and others privately financed and constructed would fully complement the 30-mile long, 10,000-acre recreation lake along a shoreline of about 110 miles and a scenic river corridor of about 12 miles to link the recreation areas with existing State parks and forests, State game preserves and the Allegheny National Forest.

d. Powerhouse - A powerhouse located southeast of the dam site on the left bank of the river to contain one conventional 120,000 KW generating unit, two reversable 120,000 KW generating units and one reversable 60,000 KW generating unit for a combined electrical generating capacity of 420,000 KW.

e. Pumped Storage Reservoir - An upper storage reservoir of 15,500 acre ft. capacity located south of the dam on a high plateau overlooking the river below the main dam.

f. Acid Drainage Abatement and Land Reclamation - A combined acid drainage abatement and strip-mine reclamation program for backfilling about 20,000 acres of stripped land, including mine sealing; grouting and other necessary structural measures.

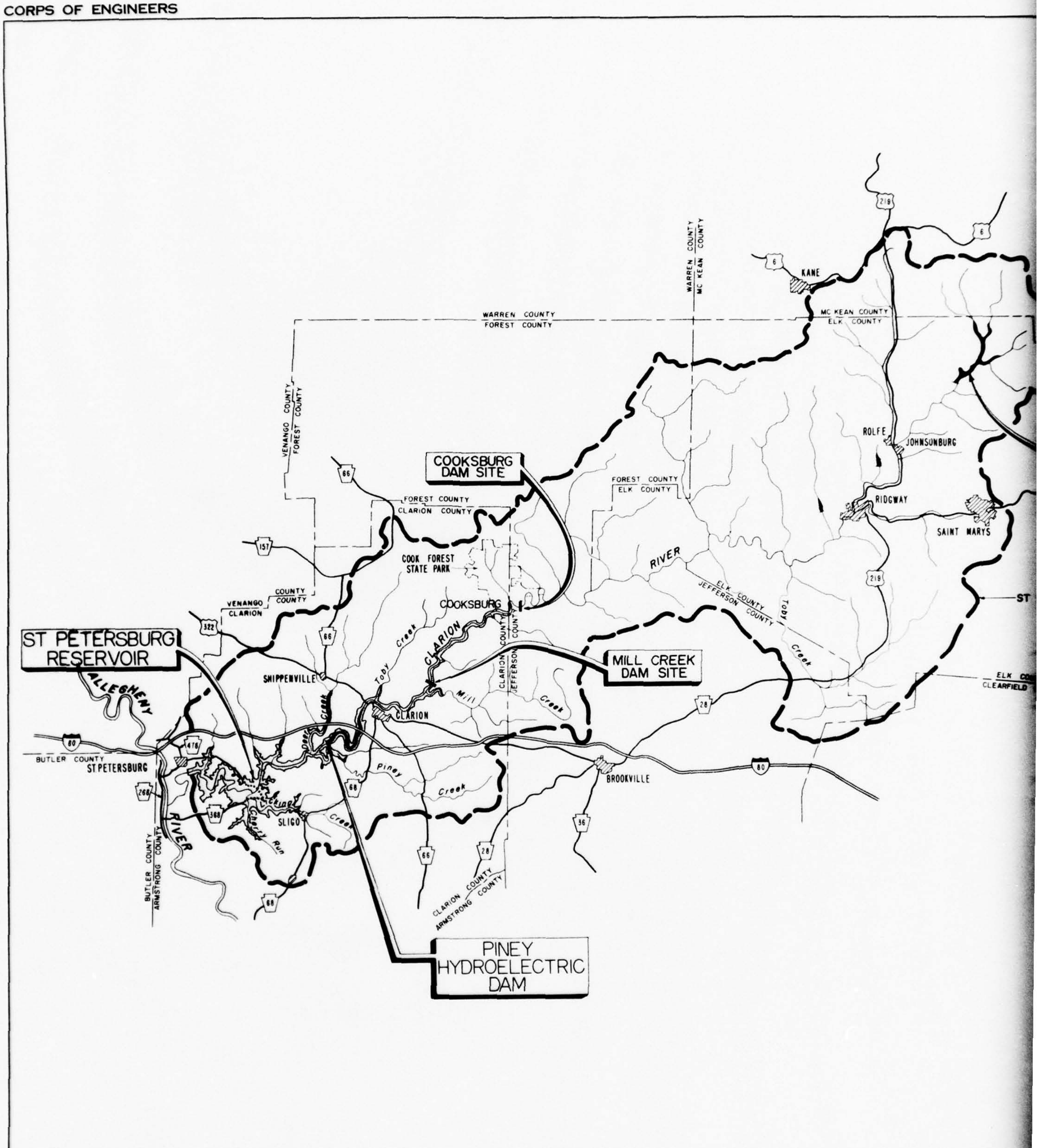
g. Industrial and Commercial Development - Potential opportunities for inducement of project oriented industrial and commercial development related to the following areas in the project vicinity:

(1) Industrial land sites on the Allegheny River of about 2,500 acres, and

(2) Over 30,000 acres of land in surrounding areas for extensive industrial, commercial and residential use.

2. PROJECT IMPACTS

Problems and needs which received consideration in formulation of a total project plan of associated developments, and the adequacy of the components of the proposed plan in fulfilling these are relevant to the following:


ST PETERSBURG
RESERVOIR
COOKSBURG
DAM SITE
MILL CREEK
DAM SITE
PINEY
HYDROELECTRIC
DAM
WARREN COUNTY
FOREST COUNTY
WARREN COUNTY
MC KEAN COUNTY
MC KEAN COUNTY
ELK COUNTY
VENANGO COUNTY
FOREST COUNTY
FOREST COUNTY
CLARION COUNTY
FOREST COUNTY
ELK COUNTY
ELK COUNTY
JEFFERSON COUNTY
CLARION COUNTY
JEFFERSON COUNTY
CLARION COUNTY
ARMSTRONG COUNTY
BUTLER COUNTY
ARMSTRONG COUNTY
BUTLER COUNTY
VENANGO
CLARION
KANE
ROLFE
JOHNSONBURG
RIDGWAY
SAINT MARYS
COOK FOREST
STATE PARK
COOKSBURG
SHIPPENVILLE
CLARION
ST PETERSBURG
SLIGO
BROOKVILLE
ALLEGHENY
RIVER
CLARION
RIVER
Toby Creek
Mill Creek
Piney Creek
Cherry Run
Deer Creek
Licking Creek
Toby Creek
80
66
157
322
66
68
68
66
28
36
28
80
268
368
476
219
219
6
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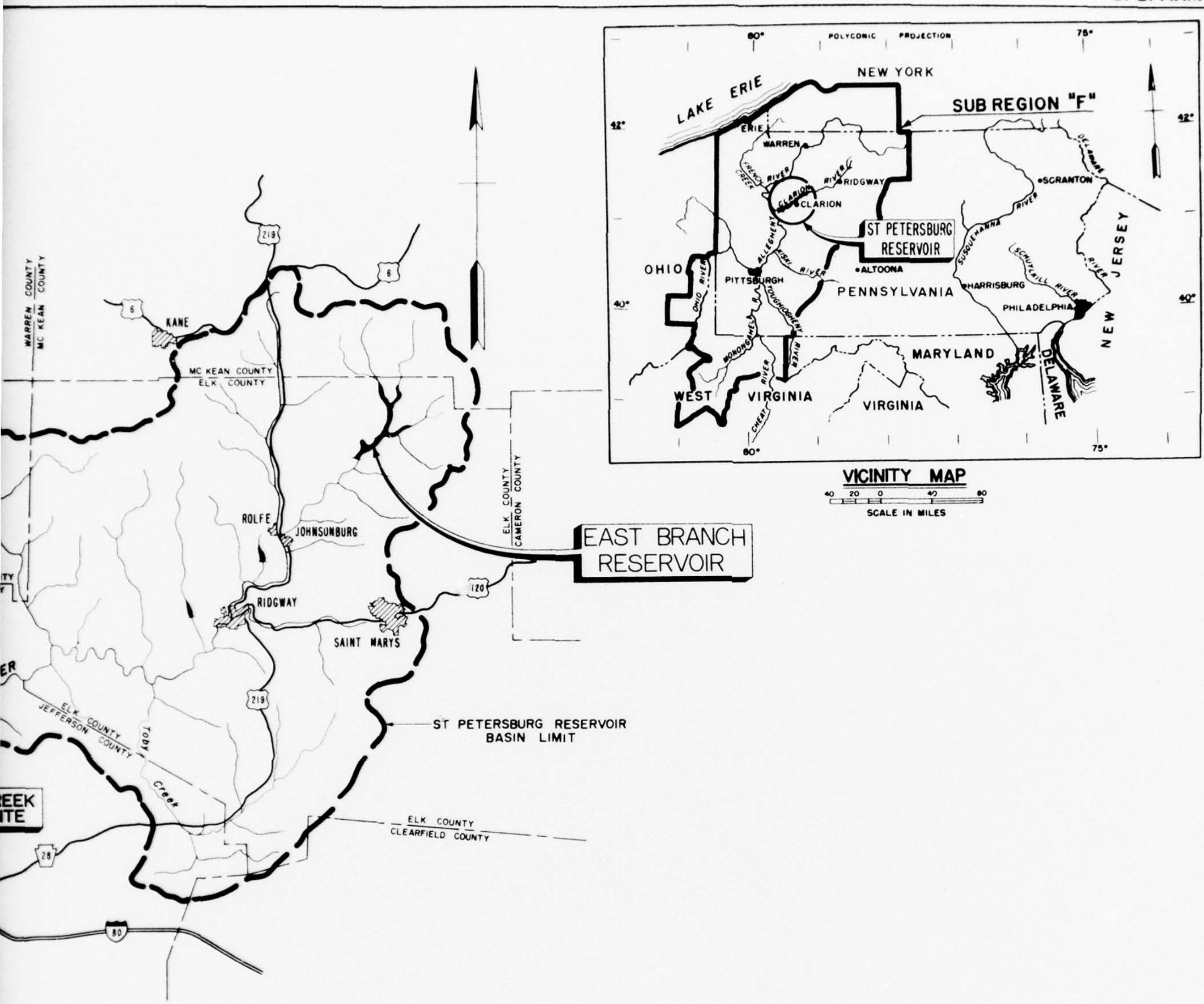

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
CLARION RIVER, PENNSYLVANIA
ST PETERSBURG RESERVOIR

BASIN MAP

3 0 3 6
SCALE IN MILES

FIGURE 11-1

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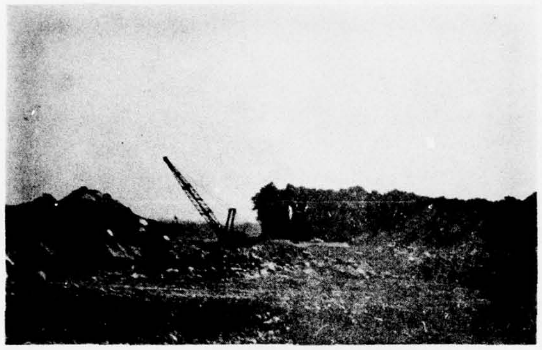
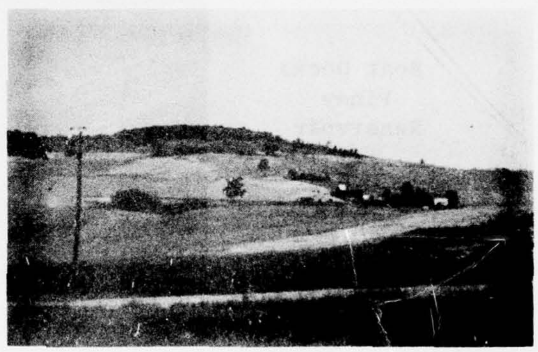
Clarion River
below
Piney Reservoir



Active Strip Mine
Operation

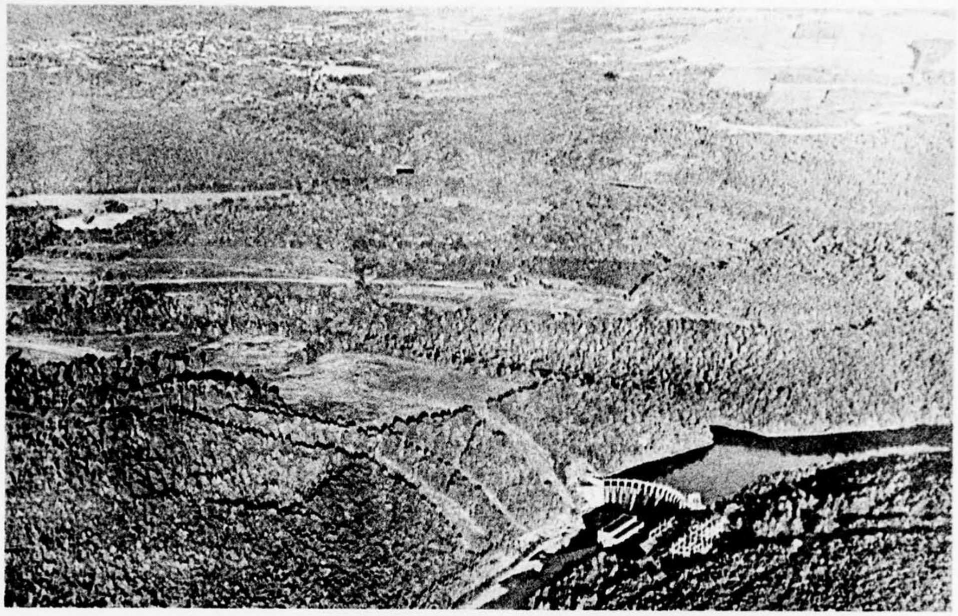
Reclaimed Strip
Mine Area



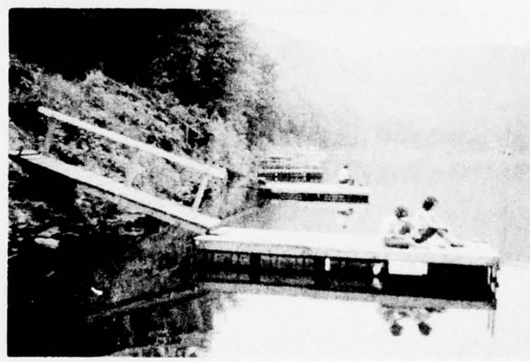
Typical Farm Land Inundated
by Reservoir

ST. PETERSBURG RESERVOIR
GENERAL RESERVOIR
AREA

EXHIBIT 11-1

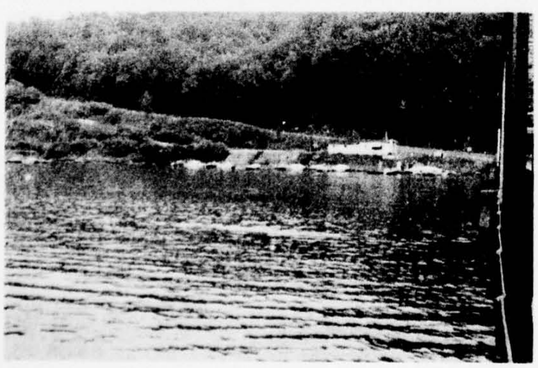


Piney Dam & Reservoir (Aerial View)



Boat Docks
Piney
Reservoir

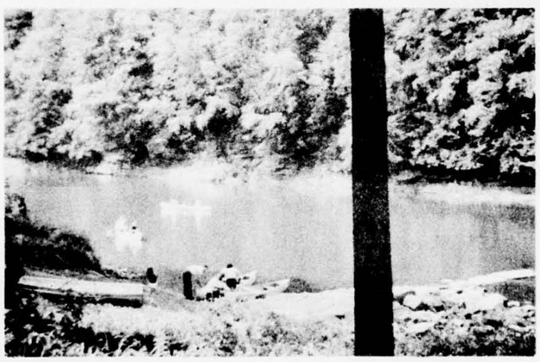
Boat Launching Area
Piney Reservoir



PINEY
HYDROELECTRIC
DAM
&
RESERVOIR

EXHIBIT 11-2

Entrance to Cook Forest State Park



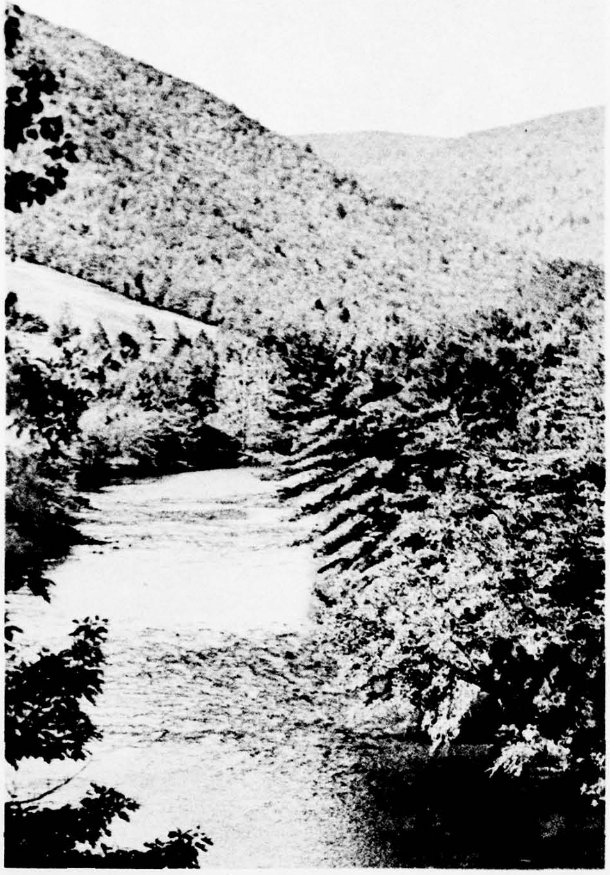
Canoeing in Clarion River Adjacent to Cook Forest State Park

Clarion River Near Cook Forest State Park

Clarion River near Cook Forest State Park

COOK FOREST
STATE PARK

EXHIBIT 11-3



CLARION RIVER
BETWEEN
COOK FOREST STATE
PARK AND RIDGWAY, PA.

EXHIBIT 11-4

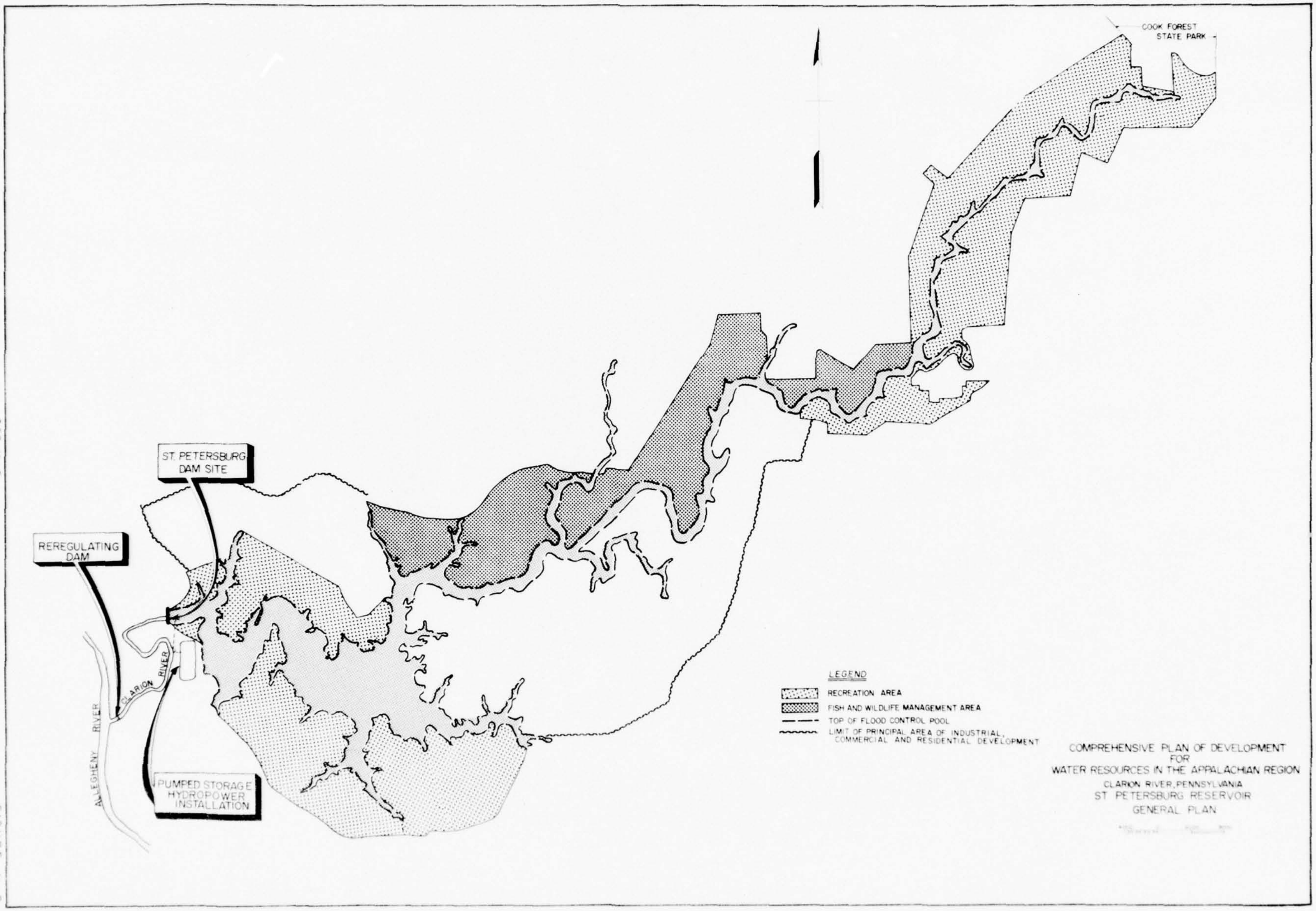

COOK FOREST
STATE PARK
ST. PETERSBURG
DAM SITE
REREGULATING
DAM
CLARION RIVER
ALLEGHENY RIVER
PUMPED STORAGE
HYDROPOWER
INSTALLATION
LEGEND
RECREATION AREA
FISH AND WILDLIFE MANAGEMENT AREA
TOP OF FLOOD CONTROL POOL
LIMIT OF PRINCIPAL AREA OF INDUSTRIAL, COMMERCIAL AND RESIDENTIAL DEVELOPMENT
COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
CLARION RIVER, PENNSYLVANIA
ST. PETERSBURG RESERVOIR
GENERAL PLAN

FIGURE II-2

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Flood Control

Except for 72.4 square miles of drainage area behind East Branch Dam and the minor incidental storage effects of Piney Reservoir, there is no control of the remaining 1,245 square miles of Clarion River drainage area above the proposed dam site. Consequently, in view of the effect of the Clarion River, the proposed improvements are an integral and vital part of the overall systems need for flood control on the Allegheny and Upper Ohio Rivers to reduce present measurable flood damages to existing development in these affected reaches from an estimated $1.69 million annually to an estimated $0.7 million annually with the proposed Clarion River improvements. Additional damage reductions on the Middle and Lower Ohio Rivers exceed $1 million anually.

Economic Development

Appalachia Pennsylvania has lagged the Nation and the rest of the Commonwealth by most economic parameters. The proposed improvements will assist in stemming this decline and the continuing population shift by making Appalachia Pennsylvania more competitive. By relief of water-related developmental impediments, a framework of lands and facilities for public, quasi-public and private investment opportunities will be established in Appalachia Pennsylvania in the nucleus of growth centers shown on Figure 11-3 and principally in the vicinity of Clarion; Ridgway-St. Marys; along the lower Allegheny River in the Kittanning-Ford City area; and in the further downstream river reaches and communities of the lower Allegheny River, and the Ohio River to well below Sub-region F. Associated economic effects are anticipated in the eight-county area immediately surrounding the project area, and to some extent in the Pennsylvania Northwest and Northcentral Local Development Districts and in the New York State Planning Sub-Region 1 contiguous to these districts. The plan for reservoir project development includes for the purpose of economic development, features and units engendered to produce stimulative economic gains to offset present deficiencies of a major nature. Environmental features and the influence of the project area's remarkable scenic and ecological environment upon potential recreational development provide an especially unusual opportunity to protect and preserve the area's most valuable natural features, and simultaneously to enhance the total environmental and economic development potential by restoring the lands involved for many years in strip mine exploitation and by providing biological recovery of the area's streams now heavily laden with acid mine drainage. Present developmental opportunities of the project area are somewhat meager, although in its adjacent and neighboring urban and rural areas are included the cultural and educational center at Clarion State College and the tremendous existing but latent possibilities attaching to the Allegheny National Forest and the Commonwealth of Pennsylvania's Cook Forest and Clear Creek State Parks and State Game and State Forest areas and developments. For these many reasons, the optimum development envisioned would provide the reservoir project and its varied and multiple-purposes as a nucleus

GROWTH AREAS
BENEFITED BY
PROJECT

FIGURE 11-3

to which could be added the wild and scenic river resources to obtain revitalization of the entire potential of the Clarion River Valley for conservation, and an economically rewarding recreational and developmental program.

Water Quality

The presently polluted waters of the Clarion River create water quality constraints in the growth center areas and affect downstream uses for municipal and industrial purposes. The pollution is caused mainly by sulfuric acid from abandoned and active mines and chemically related mineral salts and sediment formation and deposition. The proposed acid drainage abatement and land reclamation program will improve Clarion River flows to near alkaline conditions and together with the allocated storage in the proposed impoundment for water quality, will provide both in-basin and downstream waters at a quality commensurate with needs as reflected by optimum Federal and State water quality standards.

Water Supply

It is estimated that, with advanced treatment measures, existing water resources of the Clarion and Allegheny Rivers can generally meet present and future water supply needs of the growth center area, except that it has been found that additional water will be needed at Clarion due to poor quality surface and subsurface water. The plan will resolve these problems and will meet additional municipal and industrial needs related to proposed new commercial, residential and industrial developments expected in the area.

Environmental Quality for Recreation, Conservation, and Fish & Wildlife Enhancement.

Because of canyon-like topography, the river areas and present Piney Lake are inaccessible and water quality is marginal relative to support of fish and plant life. Facilities at this project and upstream areas for water-based recreation are too limited to meet present demands in view of the expanding population and economy and increased leisure time in the recreation market area. The future unsatisfied demand will be ever greater. The proposed recreational component of the developmental plan is strategically located with respect to the industrial complex to the north at Erie, Pennsylvania; to the south at Wheeling and Pittsburgh, Pennsylvania; to the east at Johnstown and Altoona, Pennsylvania; and to the west at Youngstown, Ohio, so that the estimated average annual recreation day use projected to the proposed project amounts to 3,360,000 in comparison with present day water related use which amounts to 100,000 recreation days annually. The proposed plan also offers enhanced opportunities for sport fishing amounting to an estimated increase of 169,000 mandays annually, as compared with present conditions; and a commercial fishery potential of about 150,000 pounds of food and industrial fishes per year.

Power

The power producing potential of the Clarion River Basin exceeds the current limited hydropower generation capability of the run of the river Piney Hydroelectric Development. The hydroelectric power potentialities of the proposed improvement are capable of an average annual output estimated at 650,000 kwh, which the local power market area can absorb according to the regional office of the Federal Power Commission. Electrical cooperatives in the immediate eight-county area will be a part of the consuming market upon termination (anticipated in the 1980's) of preferential agreements with Niagara-Mohawk. The hydroelectric power feature of the project could enhance the economic development opportunities needed in the project area and the sub-region.

3. COSTS AND BENEFITS

Costs for constructing St. Petersburg Dam and Reservoir, including the pumped storage power plant, pollution abatement and land reclamation measures, and recreation and other facilities, are estimated to be $240 million; annual charges are estimated to be $12.2 million. The economic development which can be related to the reservoir project, as outlined above, will cost on the order of $588,488,000 with annual average equivalent charges of $16,469,000. Annual benefits for the development are estimated as follows:

	Income	
	National	Regional
Users of the water project services	$16,931	$14,618
Expansion effects		
Redevelopment	1,290	3,320
Development	3,342	61,850
Total Expansion	$ 4,632	$65,170

Using the preceding, the ratio of the National user plus redevelopment benefits to the water project costs, indicates a minimum user index of performance of 1.5. The ratio of the total regional expansion benefits to total costs indicates an index of performance with respect to increasing regional income of 2.3.

4. COOPERATION REQUIRED FOR CONSTRUCTION

In accordance with present Federal policy, costs of the proposed St. Petersburg Dam and Reservoir Project have been apportioned appropriately between Federal and non-Federal interests. The Corps of Engineers would construct and operate the project. However, operation of the reservoir would be coordinated with non-Federal interests who would operate and maintain general outdoor recreation and fish and wildlife and other public and private facilities and with those interests which may acquire future rights to allocable storage space.

Construction costs and operation and maintenance costs allocable to flood control are apportioned to the Federal Government under existing applicable flood control legislation under the view that flood control benefits are general and widespread. Construction, operation, and maintenance costs allocated to water quality control are apportioned to the Federal Government under provisions of the Water Quality Act of 1961, as amended, (PL 87-88). The FWPCA determination of need for water quality control confirms that these benefits are widespread, extending along the lower Allegheny River and the Ohio River. Project associated joint costs attributable to acid mine drainage pollution abatement are apportioned to the Federal Government and are included in costs allocable to all project purposes. Construction costs and operation and maintenance costs allocated to power are initially apportioned to the Federal Government. These costs will be recovered from power consumers over the useful life of the power component of the project plan. However, subsequent provisions can be made for apportionment of the separable costs of power to a non-Federal entity after submission to and approval of its application by FPC. One-half of the separable costs of recreation (including fish and wildlife enhancement measures) are apportioned to

non-Federal interests, who will agree to operate and maintain the facilities and lands under provisions of the Federal Water Projects Recreation Act, (PL 89-72). The remaining separable costs and all joint costs allocated to recreation are apportioned to the Federal Government. A portion of the joint costs of the project were allocated to regional income expansion and are apportioned to the Federal Government. A summary of apportioned costs is presented in the following tabulation:

Purpose	Apportioned Construction Costs ($1,000)	
	Federal Government	Non-Federal Interests
Flood Control	$ 33,304	0
Power	68,219	0
Water Quality	33,494	0
Recreation	41,869	13,900
Regional Income Expansion	49,214	0
TOTAL	$226,100	$13,900

The Commonwealth of Pennsylvania will support the reservoir project as formulated and will undertake the responsibility for providing the assurances required of non-Federal interests. Prior to construction, the Commonwealth and other non-Federal interests will furnish assurances to repay their share of the apportioned costs; establish project area land and water zoning and downstream encroachment lines to permit efficient reservoir regulation and orderly commercial, residential and industrial expansion; contribute to a basin program of pollution control (particularly acid mine drainage) and land reclamation by providing adequate treatment or other waste control methods within their legal capability, and exercise control against diversion of streamflow made available for water quality control.

5. DISCUSSION

The major premise of the planning effort leading to selection of the proposed plan concerns solution of those problems inhibiting development in the Pittsburgh nucleus area, contiguous local development districts, and generally in Appalachia Pennsylvania. The proposed improvements will provide the water and related goods and services to stimulate the improvement and growth of the lower Clarion River Area. The plan was formulated also to be in consonance with overall comprehensive river basin plans of the Allegheny and Ohio River Basins and to assure optimum development, utilization, and conservation of the

land, ecology and related resources of the Clarion River Basin. The plan is keyed to a systems approach to water resources developments to satisfy needs of sub-region F and contiguous sub-regions.

Detailed study of the Clarion River Basin was well underway when Congress passed the "WILD AND SCENIC RIVERS ACT" (PL 90-542) on 2 October 1968. Under Sections 5 of that Act, the Clarion River between Ridgway and its confluence with the Allegheny River is designated for study for potential addition to the Wild and Scenic Rivers System. In accordance with the provisions of the Act, full project and related information has been provided to the Secretary of the Interior and to the Secretary of Agriculture to arrive at ecological compatibility of basin resources and developments. Coordination and exchange of data will continue under a Federal-State task force arrangement. Currently, a comprehensive and detailed analysis of the free-flowing characteristics of the designated reach of the Clarion River is underway by the task force and will not be complete for some time.

However, in view of the present development of the lower reaches of the river and the environmental quality enhancement measures proposed in the developmental plan, it is the position of this report that the best use of the Clarion River would be the developmental plan coordinated with the wild and scenic potential of the river above the impoundment area as proposed. It is noteworthy that the proposed project plan would not significantly affect adversely that portion of the river which is presently unaffected by access roads, shoreline developments, and impoundments. Therefore, it is believed that the proposed plan overall is suitable and complementary with respect to a well-balanced recreational and ecological development of the basin. At a public hearing held at Knox, Pennsylvania, on 18 June 1968, local interests stated their support of the plan in all of its aspects and, at the present time, there are no known organizations which oppose construction of a dam below the site of the existing Piney Reservoir.

The initial construction expenditures for this project and its related developments will insert new income into the project area. Subsequent development will sustain an advanced economy estimated to be sufficient to increase average annual per capita income for the region to a level comparable with the rest of the nation, and would attain Appalachian developmental benchmark objectives. The economic development plan for the Clarion River Basin and the lower Allegheny River Basin above Pittsburgh includes the St. Petersburg water resources project and associated project developments for recreation housing, commercial and industrial development. The associated development will occur not only in the immediate project vicinity, but also in the surrounding area, and downstream through the major industrial areas involving the Pittsburgh and Wheeling Regional Growth Centers. A capsulation of contemplated developments in Clarion and Armstrong Counties alone envisions 7,100 new job opportunities by 2020 related

to industries which are projected into 2,230 acres of developable lands. Commercial job opportunities and services supporting industrial economy are expected by 2020 also. Job opportunities along the lower Allegheny River and the Ohio River are not evaluated, but these are significant in view of the contrasting developmental problems in the Pittsburgh-Allegheny County sector of the Metropolitan Pittsburgh area and the burgeoning developments occurring along the Ohio River. The problems at the Pittsburgh nucleus are monumental as regards outmigrations, and the need for more and better protected lands along the inland waterway system. In view of the high contribution of the Clarion River to these problems, the plan selected was formulated to include those purposes that would meet these needs.

The need for water quality improvements in the Allegheny and Ohio Rivers is associated with need for a comprehensive acid drainage abatement program in the Clarion River Basin. This includes restoration and reclamation of a relatively small percentage of strip mined areas which contribute a large percentage of acid according to the FWPCA report */ on a joint pollution study conducted with the Commonwealth. The need for abatement as reflected in this joint study evaluation amounts to a minimal cost of $3.0 million according to FWPCA based on information which is considered to be of a preliminary nature and consequently not considered as totally applicable as a firm estimate without expansion to include adaptation of an alternative and more comprehensive State program.

It is necessary therefore to reflect the Commonwealth's appraisal of a more complete abatement problem in the entire Clarion River Basin as it reflects on the water quality and storage characteristics of the proposed impoundment. The Commonwealth's estimate of the total basin acid drainage abatement and land reclamation program amounts to $60.0 million, involving backfilling 20,000 acres and burial of refuse ($30.0 million); mine sealing, grouting, surface diversion, etc. ($15.0 million), and construction of five treatment plants ($15.0 million).

Analysis of the cost estimates by FWPCA and the Commonwealth with limited and comprehensive objectives, respectively, has been made to obtain a project oriented program to establish a water quality impoundment and water quality releases along with an independent cost study made expressly for the project purposes. These studies indicate that an effective project program can be accomplished at a cost of $16.7 million, **/ including contingencies, a detailed watershed study and engineering costs. The balance of the program to approach complete realization of optimum conditions for state water quality and environmental objectives exceeds the scope of project requirements and

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*/ FWPCA Mine Drainage Report, Clarion River Basin. (Appendix C) See also Appendix D.

**/ See Cost Estimate Section.

accordingly would be dependent upon assumption by non-Federal interests. These further measures are, of course, subject to the degree to which the Commonwealth finds it feasible to proceed, particularly with respect to establishment of fisheries on tributary streams, but the amount and cost of Federal participation will not be materially revised by those further studies. However, the measures included in the plan are an essential and integral part of any subsequent plan that may be developed and will be fully compatible with that plan. Under its Land and Water Conservation Act of 19 January 1968, the Commonwealth of Pennsylvania has adequate authority to assist local interests concerning prevention, control, and elimination of pollution and mine drainage. Therefore, it is believed that the measures proposed are adequate and appropriate to realize a quality water impoundment which will meet the Commonwealth's standards.

At the time of the public hearing, local interests expressed some concern regarding housing problems for communities that would be displaced by the improvements. Since that time, Congress has enacted new legislation concerning resettlement of families, individuals, and business concerns displaced by water resource improvements (Sec. 209 of 1968 River and Harbor Act). It is therefore believed, that potential relocation problems that would be caused by construction of the proposed plan, would be significantly lessened by application of the provisions of the Act.

With respect to power, costs allocated to power can be recovered over a 50-year period, and the separable cost of including hydropower in the multiple-purpose plan is less than the least costly alternative with comparable financing. Generally, utility companies especially cooperatives, are not opposed to the plan as indicated by their views at the public hearing and subsequent provision can be made for non-Federal assumptions of all or part of the power functions included in the plan. A responsible public utility has expressed an interest in such an arrangement.

Incidental benefits that would accrue from the power features of the plan include flood control effects on the main-stem reaches within Sub-region F and to points further downstream. Flow releases for water quality control and from power releases not returned to the reservoir, would augment downstream flows for navigation. Navigation benefits are relatively minor and have not been tangibly evaluated.

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SECTION II - PROJECT FORMULATION

6. NEEDS THAT POTENTIALLY CAN BE MET BY DEVELOPMENT OF WATER RESOURCES

Summary

In identifying developmental opportunities for the sub-region, the principal objective was to determine the manner and degree to which new water and related resources investments are needed to make the area and Appalachia Pennsylvania more competitive with the rest of the nation and to remove primary impediments to growth. An examination of the social, developmental, and economic aspects of the area was made with regard to the objectives of the Appalachian Act, and evaluated relative to accelerated economic growth objectives. Results of this appraisal*/ indicate that general water related problem areas concern a wide field of needs of varying intensities which are associated with: the present state of water resources developments; the present quality of the resource; and heterogeneous individual area (growth center) needs within the sub-region's enormous and loosely integrated developmental pattern. The degree to which these can be measured and met by water resources investments governed the selection, formulation and justification of potential projects in the sub-region, particularly in relation to the major metropolitan areas and their many satellite industrial cities. The relativity of needs and growth implications for these major growth locations narrowed water resource project needs and selections to most necessarily relieve the largest share of the total of the problem areas which exist at the present major growth concentrations, with employment of the fewest projects with the most optimum multiple-purpose characteristics. Consequently, of the general water problem areas constraining growth, a major water related need was found for the following:

a. Flood control measures to prevent water and associated flood damages to existing and prospective development, and to make available for development a significant area of lands now unutilized or under-utilized along extensive reaches of the lower Allegheny and the Upper and Lower Ohio Rivers.

b. Water quality control measures and programs for improved future low flow augmentation to assimilate various degrees of treated wastes at Pittsburgh and other Ohio River communities and to obviate acid mine pollution that presently limits the recreation and fish and wildlife potential of the streams and land of the area, will pollute potential municipal and industrial water supplies, and will constrain in many other ways improvement of the environment and the potential for growth.

c. Hydroelectric power generation to competitively promote and sustain sub-regional and local developments.

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*/ See Chapter 12, Part II

d. The most extensive general outdoor water-related recreational opportunity requirements in Appalachia that would be conducive to inducement of new and diversified industries and to realize the utmost of the unique scenic recreational water and land potentials of the area.

e. Other environmental and recreational enhancements related generally to existing and planned State and Federal fish, game and forest-based recreation and conservation investments.

General Water Resource Problems and Growth Constraints

Presently, of the regional growth areas (SMSA's) of the sub-region, there are three where the existing major metropolitan areas have the outstanding share of major water related growth constraints: the industrial complexes of Erie and Pittsburgh, Pennsylvania, and Wheeling, West Virginia. Also, potential growth centers and growth opportunities exist in the Northwest and Southwest Local Development Districts in Clarion, Armstrong and other adjacent Counties northeast of Pittsburgh and along the lower Allegheny River between the mouth of the Clarion River and Pittsburgh.

In order to reduce unemployment and outmigration, and other factors inhibiting progress and thus to attain relative parity with the rest of the Nation, most communities bordering the Allegheny and Ohio Rivers are actively seeking new industries to capitalize on their development of locational and resource assets. About 5,000 acres of prime industrial land which are now vacant along these rivers below the mouth of the Clarion River have not been developed principally because of flood hazards which remain after present reservoir system flood control effects, and of other related factors which have further prevented consolidation of efforts to develop these areas along the rivers. Consequently, there is presently a general lack of inducement for development. In addition, there are extensive land areas within the Clarion River Basin with a significant potential for industrial and urban use. The major impediments, to development of these lands and realization of their optimum potential, are acknowledged to be water related. The major needs of the area, which are directly water related, concern flood damage prevention, water quality control and water supply, hydropower and water-based outdoor recreation. Removal of these constraints would release the existing development potential and enhance the existing environmental resources. Within the context, that the Clarion River or some part thereof could remain in its present state or could be returned to its natural or a free-flowing state, this need is also water related. Therefore, the major thrust of this study is directed toward developing a plan in the Clarion River Basin which will provide for flood control, water quality control, hydropower and recreation that would compliment the preservation objective, as the most feasible addition to the sub-region's water and related resources base. A further discussion of the character and quantity of the needs relevant to the sub-region and to the growth centers is given in the following paragraphs.

Flood Control Needs

Flood damages to lands and existing developments along the Allegheny and Ohio Rivers from the mouth of the Clarion River to Hannibal Lock and Dam, mile 127.2 on the Ohio River currently average nearly $1.7 million per year, occurring at the following locations: */

TABLE 11-1
AVERAGE ANNUAL PRIMARY FLOOD DAMAGES
(JULY 1967 VALUES)

Damage District	Damages
Parker	776
Kittanning	58,050
New Kensington	96,700
Pittsburgh	669,500
Montgomery	59,400
New Cumberland	191,000
Wheeling	506,665
Hannibal	106,300
Total (rounded)	1,688,000

*/ See also 100-year flood profiles, Section V, Chapter 12, Part II.

Based on the present rate of development and the absence of additional flood protection beyond that expected to be in operation by 1980, the average annual damages by the year 2020 are estimated to be at least $6.3 million per year or about 3.5 times the current damages. About 5,000 acres of prime industrial land now vacant along the Allegheny River below the mouth of the Clarion and along the Upper Ohio cannot be optimally developed without additional flood protection. Damages to rural areas increase these amounts materially.

Average Annual Damages in addition to the above on the Ohio River below Hannibal Lock and Dam presently exceed $10 million and will approximate $28 million by 2020.

Water Quality Needs

Water Quality needs will be a continuing and major future constraint to economic growth and environmental quality of the entire area, including principally the acid drainage problem, particularly to the growth centers in the Clarion River Basin and Pittsburgh metropolitan area. Normal excess of alkalinity of the Allegheny River can neutralize

the acid load from the Monongahela River. However, the fairly uniform contributions of large volumes of acid drainage from the Clarion River Basin and the intermittent flash flows of large volumes of acid drainage from the Conemaugh River Basin to the Allegheny River periodically turn the Allegheny River acid from the mouth of the Kiskiminetas River downstream to Pittsburgh causing occasional extensive fish kills and adversely affecting the quality of the water for municipal and industrial uses.

The Clarion River Basin pollution problem is amenable to a simpler solution at more reasonable cost, which would more feasibly permit systems use of abated Clarion River flows in combination with upstream Allegheny River flows to alleviate the Conemaugh River acid contribution to the Allegheny River.

Acid drainage presently courses through and issues from the Clarion River Basin, generated from active coal stripping operations, abandoned drift and strip mines, and abandoned oil and gas wells. A preliminary mine drainage study has been made in the Clarion River Basin by the Pennsylvania Department of Health in cooperation with FWPCA. (See Appendices C and D.) The tabulation below is indicative of six samplings made during the summer of 1966.

TABLE 11-2
CLARION BASIN ACID LOAD

STREAM LOCATION:	AVERAGE NET ACID LOAD (lbs./day)
Clarion River, at mouth	126,712
Toby Creek (Clarion County) @ mouth	47,582
Piney Creek @ mouth	19,272
Licking Creek @ mouth	16,850
Mill Creek @ mouth	16,960
Deer Creek @ mouth	13,845
Toby Creek (Jefferson County) @ mouth	14,936

Results of this study indicate that a comprehensive acid mine drainage pollution abatement program is needed in the Clarion River Basin, in order to meet the new water quality standards established under the requirements of the Federal Water Pollution Control Act, as amended (Public Law 89-753) and to meet the requirements of the Commonwealth of Pennsylvania's Clean Streams Act of 1965. It was found that abandoned strip-mine areas contribute a large percentage of the acid drainage and, therefore, restoration and reclamation of these areas are needed.

Additional streamflow augmentation is also needed on the Ohio River to insure adequate assimilation of projected municipal and

industrial wastes after secondary or higher waste treatment is provided at the source. The information given below, as furnished by FWPCA, indicates programmed future needs for water quality flows on the Ohio River.

TABLE 11-3
PROJECTED TOTAL STREAMFLOW REQUIREMENTS (CFS) IN
THE OHIO RIVER AT SEWICKLEY, PENNSYLVANIA
YEARS 1980-2020

	1980	2000	2020
January	3800	4400	5250
February	3950	4550	5400
March	4150	4800	5700
April	4550	5300	6250
May	4950	5750	6800
June	5500	6350	7500
July	5700	6600	7800
August	5600	6450	7650
September	5300	6150	7250
October	4700	5450	6450
November	4200	4850	5750
December	3950	4550	5400

The present system of existing and authorized reservoirs within the Ohio River Basin will not provide sufficient flow from storage to meet these future requirements. While the presently degraded waters of the Clarion River are not of acceptable quality for storage to assist in meeting these requirements, Clarion Basin is the most significant potential source to meet the need and will be suitable after correction by acid drainage treatment and other control measures.

Hydropower Needs

Four power supply areas, which are relevant to electric power needs, shown on Figure 11-4, are located partially within Sub-region F. Based on information from the Regional Office of the Federal Power Commission, Power Supply Area 5 will be the expected market for electric power generation at the proposed St. Petersburg Reservoir. Area 5 includes a major portion of the State of Pennsylvania, all of New Jersey, and a small portion of New York and Maryland. Additional power generation facilities must be provided in the market area to meet future needs, particularly of the cooperative utilities. Table 11-4 which is based on data contained in the Federal Power Commission's report on "Development of Water Resources in Appalachia" dated June 1968, (Appendix D) shows a need for 16 million kilowatts of additional capacity by 1980 in the market area, 20% or 3 million kilowatts of

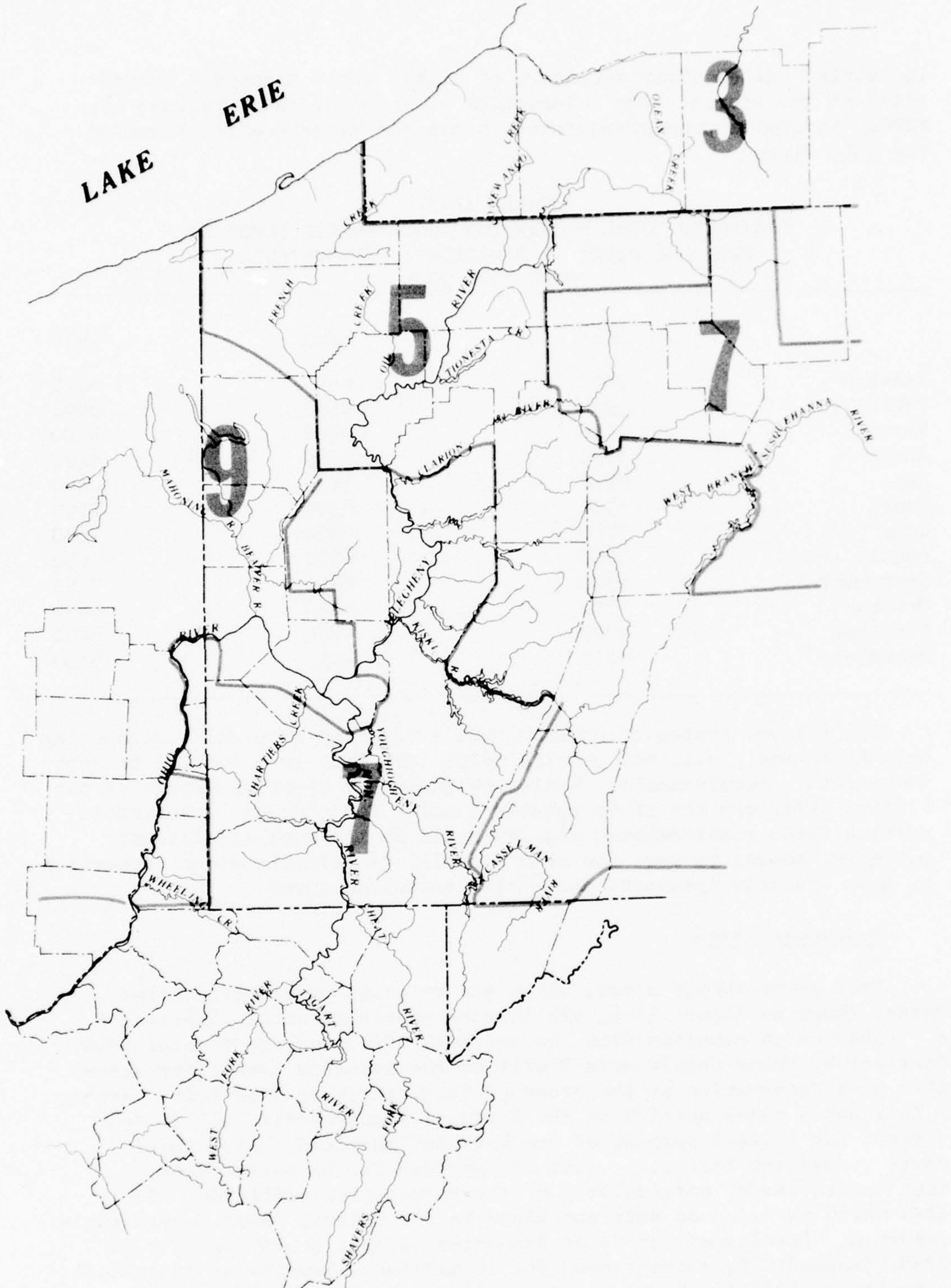

FIGURE 11-4

which would apply to new low load factor installations such as hydroelectric power. By the year 2020, the total need for new low load factor power in the market area is expected to increase to 80 million kilowatts. These are the estimated power requirements under normally expected growth conditions. Requirements for the APS developmental benchmark conditions indicate an even greater need. This indicates that power generation at the St. Petersburg (and other) sites considered in this report is needed and can be readily absorbed in the market area. The power potential of the Clarion River Basin for conventional or pumped storage power is well beyond the present small hydropower peaking capability of existing Piney Hydroelectric Development, Licensed Project No. 309.

TABLE 11-4
ADDITIONAL POWER REQUIREMENTS IN MARKET AREA

Item	Millions of Kilowatts				
	1970	1980	1990	2000	2020
Supply for load 1/	21	39	69	121	362
For reserves 2/	3	6	10	18	54
For retirements 3/	-	0	2	3	14
Total needed	24	45	81	142	430
Supply available 4/	29	29	45	81	142
Additional needed 5/	-	16	36	61	288
High load factor portion (80%)	-	13	29	49	230
Low load factor portion (20%)	-	3	7	12	58

1/ Load requirements
2/ Fifteen percent of load adopted
3/ Four percent per decade of previous load and reserve. None assumed for 1980, and adjusted for 2020 to account for two decades.
4/ Amount after 1970 is that available for last decade. Includes supply areas 5 and 6.
5/ Amount needed to be added over previous amount.

Recreation Needs

Needs for increased recreation opportunities, for general and water related outdoor activities, have been evaluated by BOR. (See BOR Appendix F.) The gross demand in annual activity days in 2020 are estimated to be 57 million and are shown by activity in the following tabulation:

TABLE 11-5
ESTIMATED GROSS DEMAND IN
ANNUAL ACTIVITY DAYS 1/
(1000's)

Activity	1960	1980	2000	2020
Boating	1,069	2,673	4,972	7,271
Swimming	5,849	13,804	24,918	36,032
Picnicking	2,474	4,948	8,189	11,405
Camping	252	835	1,741	2,242
Total Activity Days	9,644	22,260	39,820	56,950

1/ Appendix F - Recreation and Aesthetics - Bureau of Outdoor Recreation

Summary of Needs
1980
(1000's)

	Boating	Swimming	Camping	Picnicking
Demand	2,673	13,804	835	4,948
Supply	177	1,255	173	837
Needs	2,496	12,549	662	4,075

The demand for all types of outdoor recreation, and particularly water-oriented recreational opportunities, is rapidly increasing. */ Continued technological advances leading to a more efficient means of production, a shorter work week, and higher standards of living, in turn, are creating more time for leisure and vastly increased demands for outdoor recreational activities. Projected levels of population and income indicate that the demand for recreation opportunities will continue to increase, probably at the accelerated rate shown.

Generally, the Clarion River Basin lies within an area of unlimited demand (the largest in Appalachia) for outdoor recreation opportunity in the sense that full development of all facilities that could be provided on existing and potential impoundments would not meet the large metropolitan and local area demands. The Basin is centrally located with respect to the gigantic industrial complex which spans the sub-

*/ BOR Appendix F

region from the north at Erie to the south at Wheeling and Pittsburgh, to the east at Johnstown, and to the west at Youngstown. Cleveland and Buffalo on the outer fringe of this concentrated recreational market area also contribute significantly to the regional demand for outdoor recreation opportunities.

Visitation in 1967 to scenic and water areas in the Forest, Elk, Clarion and Jefferson county areas amounted to about 4.0 million to facilities which in many respects are already overtaxed. In a slightly broader complex of public areas, 1967 visitation amounted to about 5.7 million also based on inadequate facilities. Therefore, a water area on the Clarion River so centrally located to the demand, with access furnished by Interstate 79, Interstate 80, Appalachia Corridor T (the New York Southern Tier Expressway), U.S. 62 and U.S. 219, and other various state highway routes which interconnect the area, will be needed to satisfy some of the growing demand for additional water-based facilities. The environmental resources of the Clarion River area include scenic and recreational river opportunities which could furnish a kaleidoscope of recreational possibilities ranging from areas which are conducive to pursuits bordering on the primitive to those which with systematic development would appeal to the more sophisticated needs. It is anticipated by the Appalachian Regional Commission Appalachian Highland Recreation Study that an impoundment on the Clarion River could serve as a focal point for the intensive type recreation, lodges, resort hotels, convention centers and the like. This type of development would be an important source of financial income to the area, would satisfy a portion of the sub-region demand and would be a proper base for a larger developmental endeavor.

With respect to the upper reaches of the basin which is relatively undeveloped, there is an opportunity to preserve the upstream portion in its presently relatively undisturbed state.

Water Supply Needs

Although the projected water supply demands in the Allegheny River and Ohio River Basins downstream of the Clarion River will greatly increase by the year 2020, FWPCA has determined that the existing water resources of the area can adequately meet these needs. However, additional water supply will be needed in certain localized off-river areas and at Clarion, which currently is experiencing treatment problems which can only be relieved by a good quality surface source. Economic growth that could be induced by a water resource development in the Clarion River Basin would further increase the need at Clarion, and in that general vicinity. A new metropolis being studied in the area to stimulate economic development and open space protection for environmental and recreational reasons will also increase the need for future water supply.

The city of Butler, Pennsylvania, is presently solving its municipal and industrial water supply problems by pumping water from the Allegheny River in the vicinity of East Brady, Pennsylvania, (below the mouth of the Clarion River) across the Allegheny-Beaver River drainage divide to temporary storage reservoirs. The present allowable extraction is presently 5.5 mgd or 0.5 percent of the existing reliable flow of the Allegheny River. Projections indicate that by the year 2020, the withdrawal need for municipal purposes will increase to 28.4 mgd (FWPCA) or 2.5 percent of the existing reliable flow of the Allegheny River. Needs for industrial purposes if not furnished by local reservoirs will increase the demand on the Allegheny River supply. Since the users are located in the Beaver River Basin, this water is not returned to the Allegheny River. Many other communities located in headwater areas of watershed divides have insufficient water supplies.

7. ALTERNATIVES AVAILABLE FOR MEETING THE NEEDS

Alternatives Considered in Framework Studies of Sub-region F

A preliminary selection of potential projects which would offer the best possible solution to the needs of the sub-region was required in order to provide basic data for establishment and evaluation of the water resources development study. Major sites were selected in this preliminary phase from map studies. This selection was based primarily on topography, but consideration was also given to selection of those sites having an apparent storage potential and an acceptable dam site. Subsequently, field visits to each site were made by representatives of the Corps of Engineers. This reconnaissance provided information on possible engineering and geological problems which could be encountered, cultural development in the reservoir areas, and general attributes of the sites. Storage capabilities were developed in engineering studies, along with the relationships between storage capacity and structure size, and preliminary cost information. Cooperating Federal, state and local agencies provided preliminary evaluations of sub-basin needs and potential alternatives. Framework evaluations are contained in other Parts and Appendices of the report. Those sites having obvious defects such as unsuitable geologic conditions, excessive costs or relocations, apparent conflicts, and extremely poor cost to storage relationships were eliminated from further consideration. In this manner, sites were analyzed and compared. In the Pittsburgh Engineer District, a total of fifty potential multiple-purpose reservoirs were considered. Of these 50 sites, a basic plan of 32 multiple-purpose projects of which 5 are presently authorized were retained in the preliminary state of analysis.

Data on the 32 potential sites which were retained were developed in greater detail. Preliminary designs and cost estimates were made for at least two and in most cases three sizes of development. Low flow augmentation storage-yield relationships, flood reduction-storage relationships, preliminary evaluation of potential uses of the water

resource goods and services provided, and preliminary analysis of non-monetary beneficial and detrimental effects of each site were developed. Based on these preliminary gross appraisals of needs, those projects having the greatest potential for ultimate development were selected.

Local flood protection and flood prevention measures were investigated to supplement the reservoir system for flood control and flood damage prevention. Protection and prevention measures such as channel deepening and widening, the construction of walls and levees, raising of bridges, and provision of drainage systems and pumping stations were considered. Of the 58 local protection projects evaluated, 30 potential local projects along with 8 which were previously authorized were retained in the preliminary stage of analysis.

The projects which have been retained in the Framework Study Plan developed by the Corps of Engineers based on the investigations described above are shown in Figure 11-5 and also Table 12-28 and Figure 12-50 of Part II, Chapter 12. These projects, in conjunction with the water resources plan recommendations of the Department of Agriculture (Soil Conservation Service), and the States of Pennsylvania, New York, West Virginia, Ohio, and Maryland, with study areas in Sub-region F have been combined to provide the alternatives for formulation of the overall water resources plan for the sub-region.

Examination of all potential projects considered (Part II, Chapter 12) leads to the conclusion that multiple purpose storage in the Clarion River Basin would more efficiently provide for optimum needs satisfactions than any other alternative or combination of alternatives considered. Therefore, the remainder of discussions herein are restricted to the multiple-purpose development in the Clarion River Basin and alternatives thereof.

General

The range of alternatives for meeting the above needs varies from mutually exclusive alternatives of structural versus non-structural measures to a system of complimentary measures that would include structural and non-structural components. The single purpose non-structural alternative would be restoration of the Clarion to its wild and scenic state. This matter is under study by Federal-State Task Force as previously noted in this report. However, in order to provide all concerned with full information on the material benefits that would be foregone in the subsequent event that a decision is reached to set aside the Clarion River exclusively for this protective purpose, it is essential that a structural solution should also be considered. Therefore, while the desirability of restoring all of certain reaches of the river to a natural state may be an acknowledged alternative, the study of all the aspects relative to such exclusiveness involved is beyond the scope of this report.

CORPS OF ENGINEERS U. S. ARMY

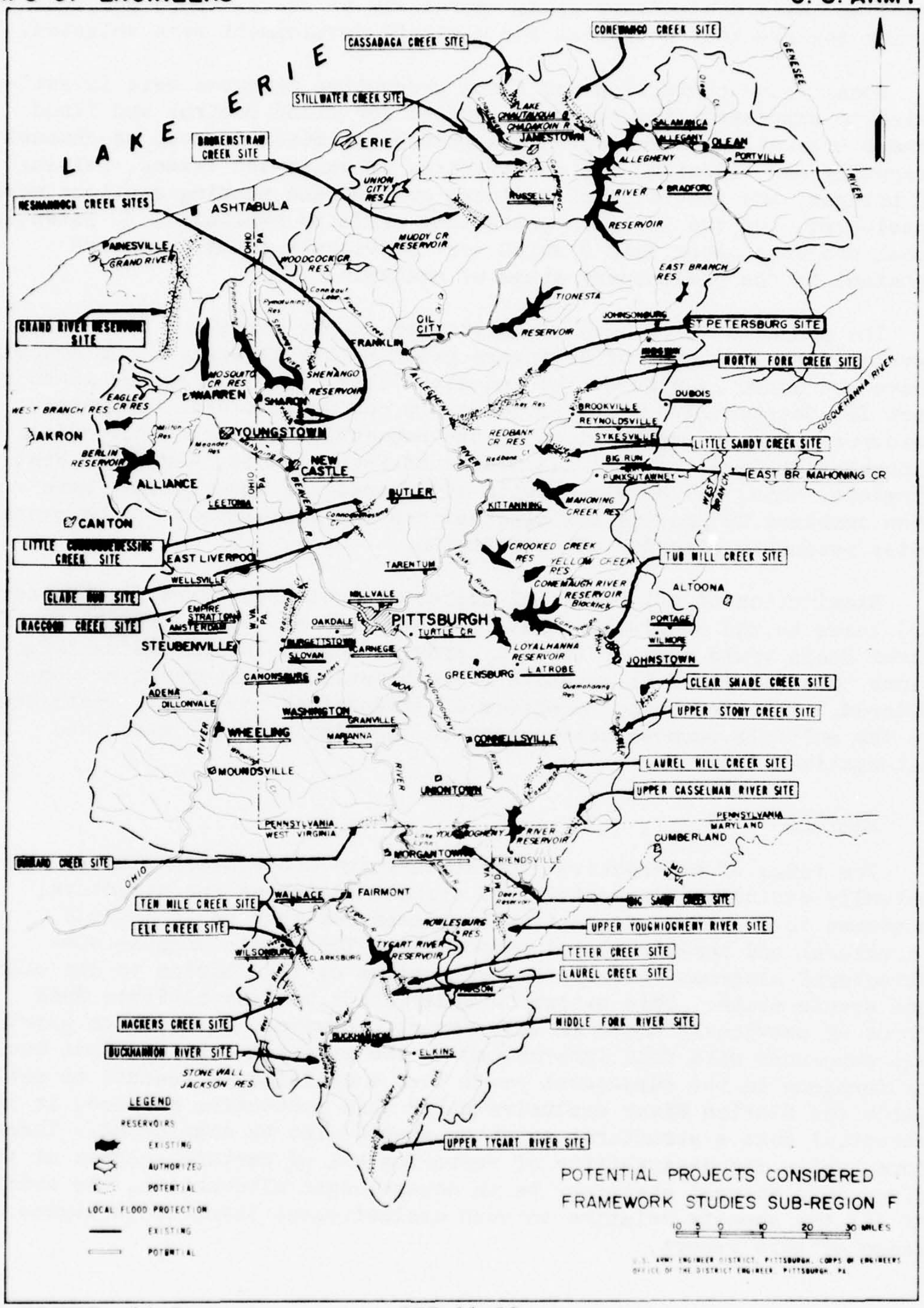

FIGURE 11-5

General plans of development were considered in the determination of the best plan for meeting the needs of the appropriate part of the Clarion River Basin and its area of influence. The major considerations are the serious flood, water and other environmental quality problems along the Allegheny River below the confluence of the Clarion River and further downstream on the Ohio River. To be acceptable, it was considered that any alternative plan would need to be compatible with existing and potential improvements and in consonance with future comprehensive river basin plans for the Allegheny and Ohio River Basins and would assure optimum utilization, economic development, and conservation of resources.

Flood Control

The Clarion River is a principal contributor to the flood control problem. The existing flood control projects are preventing large amounts of damages and have resulted in large industrial-complex development and expansion. However, because of the large uncontrolled runoff from the Clarion River Basin, there is no acceptable or economical alternative to providing additional flood control storage of substantial capacity to improve existing and future conditions. Possible alternatives available for meeting the flood control needs are discussed below:

(1) Reservoir Solutions - Potential multiple-purpose reservoir sites in the Clarion River Basin were considered for location, drainage area controlled, potential storage capabilities, and constraints to multiple-purpose development by virtue of unique ecological assets or environmental attributes considered of extreme protective value by State and Federal cooperating agencies. Conservation and protection of the latter are discussed below in relation to project selection. All but two sites (See Figure 11-1 for location) were eliminated after initial screening because of adverse topographic, geologic or hydrologic factors, or relative inefficiency for flood control. The two potential impoundment alternative sites which could possibly satisfy to some appreciable extent the need for flood stage reductions of appreciable amount along the Allegheny and Ohio Rivers are: the Mill Creek Site which is on the Clarion River immediately above its junction with Mill Creek, starting at approximately 35 miles upstream from the mouth of the Clarion River; and the St. Petersburg site which starts at approximately five miles upstream from the mouth of the Clarion River. These alternatives are discussed more fully below relative to project selection. However, although considered herein, the Mill Creek Site is presently unacceptable to the Commonwealth of Pennsylvania due to involvement in the Cook Forest State Park which contains one of the few remaining stands of virgin pine and hemlock in Pennsylvania. Future acceptance of the site by the Commonwealth is unlikely because of the large amounts of investments, especially at Cook Forest State Park.

Mill Creek Site

The Mill Creek Site would locate the dam at the head of the Piney Hydroelectric Development impoundment. Site considerations would limit flood control storage reservations to 204,000 acre-feet (5-inch runoff) in the winter and 136,000 acre-feet (3.33 inches of runoff) in the summer from a tributary drainage area of 762 square miles, not including 71 square miles already under control by the existing East Branch, Clarion River Reservoir. The effect on flood stages at Pittsburgh would be in the order of 1 foot on medium and high stages.

St. Petersburg Site

The St. Petersburg Reservoir would locate the dam near the mouth of the Clarion River and would require inundation of the Piney waterpower development. Limiting conditions at Cook Forest State Park and multiple-purpose considerations would allow the potential impoundment to have storage reservations for most effective flood stage reductions at Pittsburgh-Wheeling. Maximization of this purpose would require about 466,000 acre-feet (7.0 inches of runoff) in the winter and about 296,000 acre-feet (4.5 inches of runoff) in the summer from a total tributary drainage area of 1,245 square miles.

The opportunity for full development of impoundment characteristics at the St. Petersburg site could optimally reduce peak flood heights by about 4.5 feet at the mouth of the Clarion River, and by about 2.5 - 3.0 feet at Pittsburgh-Wheeling and downstream for the 100-year frequency flood. Flood crests of lesser frequency could also be so modified. Flood heights which would be expected to recur about once in twenty years, with the present (and authorized) degree of control, at Pittsburgh-Wheeling would be expected to occur only about once in 50 years. This reduction of flood heights or frequency of flooding will encourage the development of about 4,000 acres of prime industrial land which now lies vacant along the Allegheny and Ohio Rivers within Sub-region F below the Clarion River.

(2) Local Flood Protection Works - Consideration was given to the possibility of developing a functionally feasible plan by which flood protection could be furnished for developed and undeveloped localities along the Allegheny and Ohio Rivers where concentrated industrial developments are or can be located on lands in the flood plain. Levees and walls necessary, particularly at Pittsburgh and Wheeling have been found to be extensive in length, scope and cost, difficult of integration physically into existing developments, not desired by local interests even as a last resort, not compatible with locally desired river recreation and beautification and aesthetic potentials, and in general not conducive to the unique potentials for economic development in the Pittsburgh-Wheeling continuum because of massive utility and

transportation relocations which would be imposed on rather narrow flood plains. In addition, local protection projects of this type have the further disadvantage in these industrial locations of leaving extensive intermittent areas exposed to the flood hazard. Such areas occupying long reaches along the rivers would continue to remain vulnerable, would not be compatible to developments protected, to planned future developments within the flood plain, and orderly development and redevelopment of municipal areas and programmed infrastructural elements. On the other hand, reservoir storage would provide continuity of protection for the considerable length of river reaches downstream from the mouth of the Clarion River, thereby encouraging and supporting development. Such improvements need inducements to foster developments and expansions adjacent to sites presently developed, to take advantage of existing and programmed transportation and utility facilities and other infrastructure conducive to future development. Therefore, local flood protection works were rejected as infeasible and incompatible.

(3) Non-structural Flood Control Measures - Non-structural measures considered flood plain regulation; flood warning systems; and evacuation of the flood plain. Flood plain regulation has an economic cost in terms of lower utilization of land in the flood plain. Due to the current state of land development in the flood plain and in view of land now idle, and potentially available for industrial development, flood plain regulation would not be an acceptable solution to the flood control problem. A flood warning system presently operable has been somewhat partially valuable for flood damage reduction but only as a supplement to other flood control measures, and not as a substitute for them. Such a system, related to the rate of potential flooding in a basin, is valuable in reducing loss of life and monetary damage, by providing adequate warning so that evacuation of people and movable property can be effected from the flood plain. With respect to evacuation, removal of the existing extensive industrial development from the flood plain, such measures would be economically inefficient and would only contribute further to the present state of the economic problems of the area. Non-structural measures considered alone or in combination could reduce water damage along the Allegheny and Ohio Rivers, but they would be relatively ineffective due to the magnitude of the problem and the existing developments subject to flooding and would be incompatible with the development objective. Therefore, further consideration of non-structural measures as a solution to the problem was rejected.

Water Quality Control

The FWPCA's analysis of available stream quality and acid drainage source data indicated that water quality of the Clarion River Basin could be enhanced to an acceptable level by acid drainage source abatement. This abatement by physical construction measures of all of the active coal mining sites and at a sufficient number of abandoned strip

and drift mines and abandoned gas and oil wells would result in significant water quality improvements in the Clarion River Basin. The projected low-flow augmentation needs for assimilation purposes on the Ohio River at Pittsburgh, Pennsylvania, can be best met by a multiple-purpose reservoir constraining 110,000 acre feet of storage for water quality control. The Commonwealth of Pennsylvania has initiated a 10-year mine drainage pollution abatement program which, if completely implemented, should alleviate a large portion of the pollution from inactive mine sources in the Allegheny River Basin. Amelioration of mine drainage is being accomplished through the existing Clean Streams Law in Pennsylvania. Advanced treatment was also given consideration for meeting the water quality needs of the lower Allegheny and upper Ohio Rivers. However, secondary treatment of industrial and municipal wastes at their source, plus low-flow augmentation appears at this time to be the most economical method to meet these needs.

The possibility of providing water quality flows from sources other than the Clarion River Basin was considered. Water management procedures programmed for systems regulation to provide these total water quality streamflow requirements in the Ohio River at Pittsburgh, show by computer analyses that flow deficiencies for water quality control over the period 1929-1966 could not be met by storage and releases from existing reservoirs being operated as originally scheduled for their optimum purposes; and in the Allegheny River Basin, the Allegheny River Reservoir regulated for water quality control use of its design potential of 549,000 acre-feet of storage for such needs at Natrona; and in the Monongahela River Basin, the authorized Rowlesburg Lake regulated for water quality control use of its design potential of 572,000 acre-feet for such needs at Lock 2. Meeting the remaining needs of the Ohio River to satisfy this program requires establishment of additional system storage amounting to 110,000 acre-feet with the capability of providing a release of about 1,200 cfs for low flow augmentation in the Ohio River. Consideration was given to achieving greater flexibility and effectiveness of systems operations than presently obtainable from low flow augmentation releases from Allegheny River Reservoir relative to short time requirements for dilutions of acid slugs from the Kiskiminetas River Basin or other emergency low flow augmentation requirements. Use of additional storage capacity to increase its yield does not appear feasible because of increasing recreational use and investments. Abatement of the Kiskiminetas River acid drainage problem is far more complex than that of the Clarion River Basin, and is not as amenable to solution within a reasonable time frame, or at comparable cost.

Power

A number of alternatives were considered for hydroelectric power generation by pumped storage, flow through conventional development, or a combination of the two. The Clarion River has a fall of approximately

500 feet from Ridgway to the Allegheny River, in a distance of about 90 miles. Except in the vicinity of Cook Forest State Park and for the Piney water power development the valley is undeveloped. The valley has been considered for hydropower development by water power interests, but only one site, Piney, has materialized. Data pertaining to the existing 29 mw Piney power development is discussed below.

Most of the potential head of the Clarion River is advantageous for development of hydropower. Previous investigations*/ of conventional hydropower possibilities relate to the aforementioned Mill Creek site, potential modifications of the Piney power plant, and a site in the vicinity of Foxburg (near the present St. Petersburg site). These are shown in Figure 5 and Table 14, Hydroelectric Power Resources, Appalachian Region, 1968 in FPC Appendix B. Potential power installations considered were 70 mw, 9.6 mw and 70 mw, respectively, at average annual load factors of 28%, 60% and 28%. It was considered also that with a limited number of potential hydropower installations in prospect to meet peak demand, the prospective average annual load factor for the Mill Creek and Foxburg power plants would be reduced to approximately 20 percent and combined installed capacity would be increased to approximately 190 mw. If the Mill Creek development only was contemplated, it is probable that the installation would be approximately 140 mw and operation would be at about 13 percent average annual load factor. The former situation would appear most likely. Alternative to the Mill Creek site, to avoid conflict with the Cook Forest State Park, would be the Cooksburg site 13 miles further upstream above the Mill Creek site, and above Cooksburg (See Figure 11-1 for location). The possibility would be more costly and would have a power installation of about 50 mw at 20 percent primary annual load factor. Reregulation of power surges were considered downstream in the Clarion River and in the Allegheny River navigation pools. Total average annual output derived from these studies amount to 335 million kwh for Mill Creek - Foxburg combined, with a possibility for maximizing output to about 455,000 kwh if impoundment level constraints at Cook Forest State Park are ignored. This assumption is untenable at this time and is not expected to be removed by year 2020.

With upstream regulation in addition to existing East Branch, Clarion River Reservoir, it would probably be possible to double the existing installed capacity of 29 mw for the Piney installation. There is existing provision for one additional penstock, turbine and generator. Additional generating capacity could be provided downstream from the dam or the existing power plant.

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*/ House Document No. 491, 83rd Congress, 2nd Session dated 9 August 1954.

Hydropower alternatives studies at the St. Petersburg site included the consideration of two types of developments: conventional and pumped-storage. Alternatives were considered on the basis of two maximum pool levels, at elevations 1144 and 1155.

At maximum pool elevation 1144, it was proposed to regulate Clarion River runoff with summer flood control storage of 333,000 acre-feet (5.0 inches of runoff), and winter flood control storage of 495,000 acre-feet (7.5 inches of runoff) with water quality and water supply reservations included. Tentative plans for reservoir operation included recreational use (summer) at maximum elevation 1110 and an ungated spillway. Reservoir drawdown from June to December was based on a uniform discharge of 1,600 cfs, starting at elevation 1110. This plan does not optimize recreation. Three power plans were evaluated in a coordinated study between FPC and the Corps of Engineers from which the following condensation is made:

Plan "A" would consist of a conventional power development at the concrete dam with installation of 100 megawatts, capable of generating in the average year 240,000 megawatt-hours. The dependable power capability of such a development would require a minimum head of 140 feet which could be obtained either by raising water levels or by using less reservoir drawdown. For comparative purposes it was assumed that 100,000 acre-feet would remain in the reservoir to provide 140 feet minimum power head and the regulated outflow during an adverse year as 1964 would be reduced from 1,600 cfs to 1,400 cfs.

On this basis of reduced outflow, and dependable capacity of 100 megawatts, the annual power value would be $2,180,000. The estimated first cost of separable power facilities would be $14,000,000 and annual cost $880,000 giving a benefit-cost ratio of 2.5.

Plan "B" would consist of a pumped-storage power plant located underground southeast of the dam, with 1,200 feet of suction tunnel from Clarion Reservoir and pressure shaft to an upper reservoir. Power generation would be through 800 feet discharge tailrace tunnel to the Clarion River. Maximum generating head would be 480 feet (1,345-865) and pumping head variable from 200 to 400 feet. The installation would be with the Dariaz type units which have adjustable blade reversible turbines. An installed capacity of 300 megawatts would generate in the average year about 500,000 megawatt-hours. The annual power value would be $6,100,000. Annual cost including pumping energy at 400,000 megawatt-hours would be $2,900,000. The benefit-cost ratio would be 2.10.

Plan "C" would consist of a pumped-storage power plant at the Clarion dam with installation of 420 megawatts with three conduits from the Clarion Reservoir and pumping to an upper reservoir by tunnel 6,000 feet north of the dam. Pumping head would vary from 450 to 620

feet and average generating head from upper reservoir to Clarion River of 680 feet. Average generation and pumping energy amounts to about 700,000 megawatt-hours. Annual power value would be $8,540,000 and cost $4,550,000 giving a benefit-cost ratio of 1.90.

The following qualifications are made regarding the above alternatives:

(1) Plan "A" is contingent upon the lower 100,000 acre-feet being held in reserve for prolonged drought as in 1930 and 1964. (2) Consideration of Plan B or C are contingent upon further survey and investigation of upper reservoir sites and cost of tunnels. (3) Plan "B" will require further investigation of the characteristics of Dariaz turbine units manufactured by the English Electric Company.

It would appear now from the joint study above that these alternative facilities favor an underground power plant, located southeast from the dam, with pump-turbine installation of 300 megawatts (Plan B). Further studies during advanced engineering and design will reconsider all alternatives.

The annual power values used are based on Appalachian Region Study; that is, $17 per kilowatt year and 2 mills per kilowatt-hour. Annual costs have been based on Federal finance with fixed charges at 4.5 percent, and pumping energy at 2.6 mills per kilowatt-hour. Estimated first cost of the above alternative plans are as follows:

Plan A - 100 MW - $14,000,000

Plan B - 300 MW - $30,000,000

Plan C - 420 MW - $45,000,000

At maximum pool elevation 1155, criteria established for evaluation of alternatives are: summer flood control storage capacity of 296,000 acre-feet betwen elevations 1,130 to 1,155; winter flood control storage capacity of 473,000 acre-feet between elevations 1,115 to 1,130; and a water quality and water supply storage capacity of 673,000 acre-feet between elevations 937 and 1,130.

Reservoir operation includes maximizing recreational use in the summer with maximum pool at elevation, 1,130, and minimum summer pool at elevation 1,115, and minimum winter pool at elevation 1,111. The reservoir drawdowns during the recreational season will provide a discharge of 1,200-1,600 cubic feet per second when needed and will approach the minimum summer pool elevation of 1,115. For the period of record, 1929-1965, stage duration calculations for a continuous minimum flow of 1,200 cfs when needed indicate at least a 95 percent at or above the winter pool at elevation 1,111. Flow duration data show that the minimum continuous discharge of 1,200-1,600 cfs could be maintained as needed. Flows equal or greater than 2,000 cfs will occur about 16 percent of the time while reservoir discharges greater than 8,000 cfs may be expected six percent of the time.

The operation of the power generation cycle without control would result in extremes in daily flow release and, on weekends, little or no release at all. In addition, hazards to human and animal life may result, power operation may be attended by sloughing of banks, interference with navigation and the dislocation of, and interference generally with various activities which are already firmly adjusted. Furthermore, realization of benefits from recreation, fish and wildlife, pollution abatement, water quality, etc., which regulation of the stream would otherwise provide would be hindered in various ways by power releases, particularly an unsteady stream stage which could rise as much as 5 feet in the lower Clarion River and 2 to 4 feet in the Allegheny River. It is therefore considered essential that a reregulation dam and reservoir be provided at this time as a part of the project to protect the existing stream valves.

Two methods of hydroelectric power developments were evaluated by joint study. Additional analysis of pumped-storage power is discussed below.

Plan "A" would consist of a conventional power development at the concrete dam with an installation of 150 megawatts. The powerhouse, located at the base of the dam on the right bank, would contain two-75 megawatt units generating in the average year 280,000 megawatt-hours under a design head of 231 feet. Plant operation is planned for a weekly load factor of about 18 percent and an annual capacity factor of 21 percent. A reregulating dam, with a storage capacity of 4,800 acre-feet, would be provided about 4 miles downstream of the St. Petersburg dam site. First cost of the specific power facilities, including the reregulating dam and reservoir, is estimated at $18,100,000 with associated annual costs of $1,040,000. With average annual power benefits estimated at $3,110,000, the benefit-cost ratio is 3.0. After deducting yearly O&M and administrative cost applicable to the reservoir and capitalizing the remaining net power benefits of $2,070,000, the cost allocation that could be sustained by power is estimated to be about $45,000,000.

Plan "B" would consist of a pumped-storage power plant located underground southeast of the dam, with 1,200 feet of suction tunnel from the main reservoir and a pressure shaft to an upper reservoir. Discharge from the power plant would be conveyed to the Clarion River through a tailrace tunnel 1,000 feet in length. Two units of conventional design and rated at 120 megawatts each, would generate under a design head of 460 feet. A reversible 120 megawatt unit with a divided draft tube arrangement would be available for pumping under a head of 217 feet from the Clarion Reservoir to the upper pool (elevation 1,310-1,350) with generation either to the reservoir or to the river. A 60 megawatt reversible unit would be provided for pumping and generating from the lower reservoir to the upper pool. The total installation of 420 megawatts would provide an annual generation of 650,000 megawatt-hours. The upper reservoir storage required would be 14,000 acre-feet. The first cost for separable power facilities is estimated at $60,700,000 with associated annual costs totaling $4,780,000 including the cost of pumping energy. With annual power benefits estimated at $8,440,000 the benefit-cost ratio is 1.8. Previous pumped-storage Plan C was dropped from consideration because of uncertainties related to geology and costs for a 6,000-foot tunnel connecting the upper and main reservoirs.

The annual power values employed in the economic analyses are based on unit costs of alternative steam capacity established in 1966 for the Appalachian Region Studies. These at-site power values, based on private financing are $17 per kilowatt-year for dependable capacity and 2 mills per kilowatt-hour for energy. Annual specific power costs are based on Federal financing with fixed charges at 4.67 percent for power facilities, 3.44 percent for dams and reservoir, and pumping energy at 2.6 mills per kilowatt-hour.

An economic analysis was also made of each scheme utilizing power values derived from a privately financed pumped-storage alternative. It was found that although the power benefits were considerably reduced, the resulting benefit-cost ratios were substantially greater than unity. It was also found that the incremental capacity difference (270 Megawatts) between the two plans is economically justified.

Based upon study of alternative power possibilities at pool elevation 1,155, either a conventional or pumped-storage power installation is economically feasible as an alternative for inclusion in a comprehensive multiple-purpose reservoir development. It is apparent that although additional detail studies for power development are required in the pre-construction stage in order to establish, more definitively, power costs and benefits (economic feasibility), these two developments are legitimate alternatives to meet power needs for the sub-region. Pumped-storage power potentials increase the project net benefits. It is essential that the alternative of establishing suitable conventional power facilities initially in the concrete dam structure be established as a priority item.

Recreation

Recreational alternatives of the Clarion River Basin relate to the uniqueness of its natural environmental potentials either as impaired by the results of activities based on the extraction of minerals and other exploitations of the natural resources which have become detrimental to the total ecological system, or as more favorably affected by programs of restoration, reclamation and abatement of these despoilments. Another set of alternatives is based on the protection of the Basin as is, or as restored to a clean, free flowing river to its mouth or to the head of Piney Reservoir; and to its use as a wild, scenic or recreational river in whole or in part from Ridgway to the Allegheny River. Eligibility of the river in this reach for inclusion in the national wild and scenic rivers system is largely a matter of study of its outstanding ecological and other features and values relative to vital national conservation purposes.

Alternative recreational possibilities are as varied as the existing environment. To maximize the river potential for its many values is relatively impossible. Extremes prevail of intensive developments (including the existing power impoundment) from the river mouth to the beginning of national forest, state park, state forest, state game lands and private fishing and hunting developments at the Cook Forest State Park area. These continue through the next 55-mile reach of the river which in its downstream section is readily accessible by road and has some developments along its shoreline and in its upstream section is free of impoundment, with shorelines largely undeveloped, but accessible

in places by roads until it approaches the urbanized area at Ridgway. By existing use, the river from Cooksburg to Ridgway is therefore a recreational river, generally, bordered by extensive national forest and state and private owned lands dedicated to recreational pursuits. Left to its own devices local, public and private interests, largely influenced by access furnished by Interstate 80 will develop recreational and tourism-oriented opportunities from the river mouth to about an area upstream of where this highway crosses the river in the vicinity of Clarion, Pennsylvania.

The river above this reach is canyon-like to about the Cook Forest State Park location, with little access to the river itself, but paralleled along its upper plateau by highways. In the reach above Cook Forest the area has hunting opportunities of moderate use, with deer and black bear in its more secluded areas. The rest of the fauna is typical of the area upstream along the Allegheny River and extending into the Allegheny National Forest and State-owned forests and game lands. Recreational alternatives mainly pertain to these lands. There is a potential for heavy visitation by tourists and vacationists in the lower river valley, and by a lesser visitation by hunters and naturalists in the upper river valley.

A compromise of these opportunities to provide moderate quality and moderate yield of the total landscape is one alternative, or to compartmentalize the landscape so as to simultaneously maintain highly productive and predominantly protective characteristics as separate units subject to different management strategies. This would permit employment of alternatives for multiple-use which would probably return the greatest amount of benefits to the area. The total ecological system of the basin would not be adversely affected by development of a major water impoundment in the downstream area or by retention and further development of the existing power impoundment, and recreational river development from the head of the impoundment to Ridgway (and beyond). Therefore, it is concluded that a recreational plan could be developed that would be complimentary to a well-balanced recreational development of the basin that would become a National attraction.

Water Supply

Alternatives Available to Meet Water supply Needs - Alternatives considered to fulfill the water supply need that presently exists and to the projected economic development resulting from construction of the St. Petersburg project were: development of additional wells, pumping from the Allegheny River, small water supply reservoirs and inclusion of storage in the multiple-purpose reservoir. As pointed out by the FWPCA, wells in the Clarion area currently have limited potential yields and the water is of relatively poor quality due to pollutants. The distance from the Allegheny River to the project area makes it generally impractical to develop ground water supplies in the Allegheny

River Valley, according to USGS. However, it is also stated that ground water supplies can be developed in the lower Clarion River Valley in the downstream portion of the impoundment area. Optimum development of about 200 thousand gpd per square mile is anticipated to cost $0.17 per thousand gallons, assuming that the well field would yield 1 mgd with power costs at $0.025 per kwh, and that construction costs would be depreciated over a 25-year period with interest at 3 1/4% (real estate and exploratory drilling and testing costs are not included). These estimates stop short of actual design. With an impoundment of good quality water at hand, it is not likely that a ground water supply would be developed unless at much less cost, ease or capability of development, or of much superior quality for specialized industrial or other use. Consideration of alternatives was also made for water supply from small reservoirs of good quality water located on tributaries to the reservoir or in contiguous basins in the vicinity of the projected development. However, sites with good water located near the need area would entail a cost of storage and distribution which would be greater than if storage were included in a multiple-purpose project.

Industrial Development

Consideration was given to the possibility that suitable industrial sites could be protected for development by filling low-lying lands to an elevation above seriously damaging flood heights. While in some instances it might be an economically feasible means of protecting against or minimizing flood losses, it would contribute little to the fulfillment of other water related needs. Although further detailed study would be needed, it is believed that the cost of local flood protection works or relocation of highway and railroad developments which follow the river bank would preclude this approach. Also, land filling on a large scale would result in severe damage to adjacent properties, and would prevent orderly development of communities and urban facilities.

In the immediate study area there is about 20,000 acres of strip mined land, which would be reclaimed in conjunction with a multiple-purpose development. This land, which is almost worthless at the present time, will then become an asset, rather than a detriment, to the economic and recreational development of the sub-region. Housing and other urban developments required for project displaced communities could use this land in coordination with other project engendered needs as an alternative to complete displacement. It was concluded that there is no alternative to providing an industrial development plan to meet the need for economic development.

Other Needs

Navigation on the Allegheny and Ohio Rivers is occasionally hampered or interrupted by ice formation during protracted periods of low temperatures. Release from the storage of a reservoir in the vicinity of the St.

Petersburg Reservoir Site to augment the releases from Allegheny Reservoir, would be beneficial in alleviating this condition. With respect to fish and wildlife and environmental quality needs, there is no feasible alternative to abatement of acid mine pollution drainage and reclamation of mined out lands.

8. PROJECT SELECTION SIZING

Examination of the needs and alternatives available for meeting these needs, indicates their complex and inter-related nature. The basis for selection of a plan of improvement necessitates consideration of all factors for the optimum efficiency of the water and related land resources of the basin to meet the short and long-term needs. These factors include the tangible economic aspects, social and environmental considerations, Federal-State relations and State objectives, judgment factors, and intangible considerations. These factors must be justly weighed which is done in successively varying combinations using economic values where appropriate as a measure of outputs. With the exception of the in-progress study concerning restoration of the Clarion River to its natural state, these studies were also premised on the need to insure that any plan selected should be compatible with existing Comprehensive River Basin Plans and other plans which may be formulated.

The comprehensiveness of needs for so gigantic an economic development area as the industrial complexes which virtually surround the river basin, are potentially of proportions which require an optimum combination of resource opportunities involving one or more reservoirs and other correlative developments for the various water and related purposes which have been found to be essential to growth and income production. The best of the alternatives available initially included a number of potential reservoir development sites and allied measures for a variety of single or multiple-purpose uses. These schemes were narrowed by comparative net benefits to one large and comprehensively formulated proposed impoundment at the St. Petersburg site, with due consideration to the total basin ecological system, and to needed economic and environmental improvements and enhancements. As an initial step, maximum storage possibilities for single-purpose flood control and for multiple-purpose uses for each of the sites, were determined within the limiting factors peculiar to each site, as noted in Tables 11-6 and 11-7.

Single-purpose developments would not be as productive of net benefits as a multiple-purpose development, particularly in view of complimentary purposes which could be realized in a multiple-purpose improvement at St. Petersburg. The following discussions and analyses, illustrate that a multiple-purpose development at St. Petersburg was found to be the most feasible type and a suitable location for a comprehensive water resources development to meet the most critical and immediate needs in

TABLE 11-6
MULTIPLE-PURPOSE STORAGE
MAXIMUM SITE CAPABILITY

Item	St. Petersburg	Mill Creek	Cooksburg
Drainage Area (Sq.Mi.)	1245	833	776
Streambed Elev. (m.s.l.)	879	1080	1157
Storage (1,000's A.F. & In. R.O.)			
Gross	981.3(14.8)	856.0(21.0)	660.0(17.9)
Flood Control			
Winter	465.9(7.0)	204.0(5.0)	190.0(5.0)
Summer	295.9(4.5)	136.0(3.3)	126.7(3.3)
Water Quality	110.0(1.7)	-----	-----
Other*/	575.2(8.6)	652.0(16.0)	470.0(12.4)
Limit of Storage (Elev., m.s.l.)			
Constraint	1160	1160	1200
Used	1160	1330	1360
Surface Area (Acres)	13,590	10,650	8,900
Upper Power Pool (Elev., m.s.l.)	1350	1520	1600

*/ Supplemental storage for conventional and/or pumped-storage hydropower, water supply and water quality, and recreation.

TABLE 11-7
SINGLE PURPOSE FLOOD CONTROL STORAGE
MAXIMUM SITE CAPABILITY

Site	Drainage Area	Streambed Elevation	Storage Allocations Capacity-1000 Acre-Feet Gross	Flood Control Winter	Flood Control Summer 1/	Storage Limitation Reservoir-Full Elevation Used	Storage Limitation Reservoir-Full Elevation Constraint
St. Petersburg	1245	879	477.9(7.2)*/	465.9(7.0)*/	295.9(4.5)*/	1106	1160*/
Mill Creek	833	1080	232.0(5.7)*/	204.0(5.0)*/	136.0(3.3)*/	1241	1160*/
Cooksburg	776	1157	215.0(5.3)*/	190.0(5.0)*/	126.7(3.3)*/	1291	1200**/

*/ Cooksburg and Cook Forest State Park limitation set by Commonwealth of Pennsylvania.
**/ Clear Creek State Park limitation set by Commonwealth of Pennsylvania.
1/ For incidental recreation.

The storage limitations imposed above for each site are related to constraints set by the Commonwealth of Pennsylvania to protect its natural resources and recreation developments.

and related to the highly industrial urban areas of Sub-region F. In view of the large amount and extent of needs, other alternatives from the framework study with a lesser, but still relatively efficient capability for meeting remaining needs, are necessarily incorporated into future study-construction requirements contained in Section V, Chapter 12, Part II - Sub-region Plan. Initially, possible multiple-purpose developments at selected sites in the Clarion River Basin, were considered with regard to their full and restricted potentials resulting from constraining limiting factors; and, secondly, with respect to the site subsequently found to be the most favorable site for development, the St. Petersburg site.

The most favorable sites in the Clarion River were found to be at St. Petersburg, Mill Creek, and (an alternative to Mill Creek) at Cooksburg, and were considered for multiple-purpose development, including flood control, water supply and water quality, recreation and pumped-storage and/or conventional hydropower. These three were selected for initial formulation study.

The 1,160 elevation limitation shown in Table 11-7 for the St. Petersburg site and the Cooksburg site, relates to the Cook Forest State Park and the town of Cooksburg with respect to: virgin timber along the river on the Fire Tower Ridge, the Indian Family Cabin Development in the Tom's Run Valley, the Cook Forest Inn Concession, a planned sewage treatment plant, the Park office residence, and all of Cooksburg. The 1,200 elevation limitation for the Mill Creek site relates to Clear Creek State Park for its developments at the Family Camping and Cabin units.

From the above, it was determined that although pumped-storage and/or conventional power possibilities are comparable, site to site, the St. Petersburg site would produce the greater total net benefits and most adequately meet other needs within storage impoundment constraints, by some margin. Therefore, the conclusion was drawn that of the three best alternative sites available in the Clarion River Basin, the St. Petersburg site offers the best possibility for a multiple-purpose development and, therefore, was selected for detailed evaluation.

The potential St. Petersburg site has been previously considered in connection with a systems relationship as an integral part of the existing and potential Allegheny and Ohio River system. Trade-offs of purposes and interbasin relationships have been considered with respect to both of these systems and with the Genesee River system. The Monongahela River system, as part of the Ohio River system, was previously analyzed for possible alternative developments to the St. Petersburg site. This latter study and the other systems studies relevant to the framework study for Sub-region F gave considerations to alternatives of possible water and related resources equivalence

for multiple-purpose development attaching to three multiple-purpose reservoir sites in the Monongahela River Basin (Big Sandy Creek site-Cheat River; Dunkard Creek site - Monongahela River; and Laurel Hill Creek site - Youghiogheny River); one multiple-pupose reservoir site in the upper Ohio River Basin (Raccoon Creek site); two multiple-purpose reservoir sites in the Genesee River Basin (Portage and Stannard sites); and numerous smaller single and multiple-purpose sites in the entire sub-region system.

A final consideration concerned the objectives of the Appalachian Regional Development Act of 1965, Public Law 89-4, and the Wild and Scenic River Act of 1968, Public Law 90-542, and other Federal and State Acts pertaining to water and related resources developments, water management and water quality control. The proposed St. Petersburg development in relationship to these various Acts, was the most compatible of the sites considered that would establish a comprehensive multiple-purpose water and related resource development in the Clarion River Basin, which would permit satisfaction of a complimentarity of purposes believed to be within the intent of all existing laws. Public Law 90-542 in particular, concerning the potential eligibility of the Clarion River as an addition to the national wild and scenic rivers system, was interpreted as requiring optimal protection to those natural, ecological and environmental features of outstanding value for water quality and national conservation purposes in the river valley and its immediate environments for the greatest benefit and enjoyment of present and future generations. The river valley is uniquely endowed both ecologically and culturally to adapt to an environment whereby the existing impoundment would be replaced by one which could better meet the needs expressed by the Federal and State Acts. Consequently, it is believed that the ultimate objectives of all levels of governmental and private interests would be realized by a multiple-purpose reservoir. The relative judgment values of the environmental resources of the Clarion River from the Allegheny River to Ridgway as recreational or other type river areas are subject to the procedure for such classification and determination jointly by Interior and Agriculture in accordance with Sections 2 (b) and 4 (a) of the Wild and Scenic Rivers Act; and the preparation of a proposal based on a study report, for the addition of the Clarion River to the national wild and scenic rivers system, if found justified. Coordination between the findings of that study report and the findings of this report, should ameliorate any potential conflict of purposes within the intent of the two named Acts.

Concerning the eligibility of the Clarion River for classification under the Wild and Scenic Rivers Act, there is a discussion and evaluation below, to strike some perspective, relative to the values of the Clarion River environmental resources in a number of conditions of development, but restricted for simplicity to: their present state of

development; development as a wild or scenic river; development as a recreational river; and development as a recreation river in conjunction with a multiple reservoir development at St. Petersburg. The comprehensive Interior-Agriculture study for potential designation could result in one of these classifications or another, or in the latter combination of one or another classification that would include St. Petersburg.

More complete study*/ will be needed in the pre-construction planning stage to investigate biological effects of iron and other pollutants (aside from acid drainage) on stream and reservoir biota for adequate establishment of water quality criteria and reservoir operational procedures to protect the scenic and water quality of the river and the impoundment as a part thereof as Section 1 (a) of the Act intends. Also, to realize the best combination relative to the objectives of Section 1 (a) of the Act it would be necessary to make additional studies from a biological standpoint concerning the productivity of the waters in a post-construction, unpolluted state. It has been suggested that the geology of the area may inhibit productivity relative to fish regimen under a return to natural conditions. There is an indicated lack of knowledge, also, relative to early phases of adjustment of biota to a newly filled impoundment of this size, in this location. It is believed necessary, therefore, in the pre-construction stage to obtain observations in depth on the state of chemical, hydrological and biological conditions in the ecological system of the entire basin, or at least in the areas pertinent to the maximum wild and scenic river potential prior to construction of the impoundment. Follow-ups for comparative purposes for water quality and conservation values would be made during and after construction to evaluate pre- and post- regulation stages. Suggested initial study parameters which may serve as predictors of post-construction changes which may conceivably affect the entire scenic and recreational stream regimen to Ridgway, are indicated to be complex models to be studied in the latest and most imaginative approaches to establish relationships between runoff, groundwater flow, pH, iron, sulfates, total solids, alkalinity, dissolved oxygen, drawdown patterns, temperature, etc. before establishing post-construction patterns in the effluent of the reservoir, as well as stratification and possibly other seasonal changes within the impoundment. Associated biological changes in the impoundment and in the river above the impoundment could be correlated with these changes.
It is expected that with establishment of the most beneficial parameters in the impoundment, and proper drawdown patterns (plus continuous monitoring in the impoundment and in the upper river) that in the reservoir proper, primary production will be primarily planktonic. Due to the basin morphology, benthic consumer production may be considerable, based on planktonic primary producers dependent upon chemical conditions that may develop in the lower water layers in the summer. However, it is contemplated that fish production should be fairly high; with the expectation that the waters would be suitable for bass, pike,

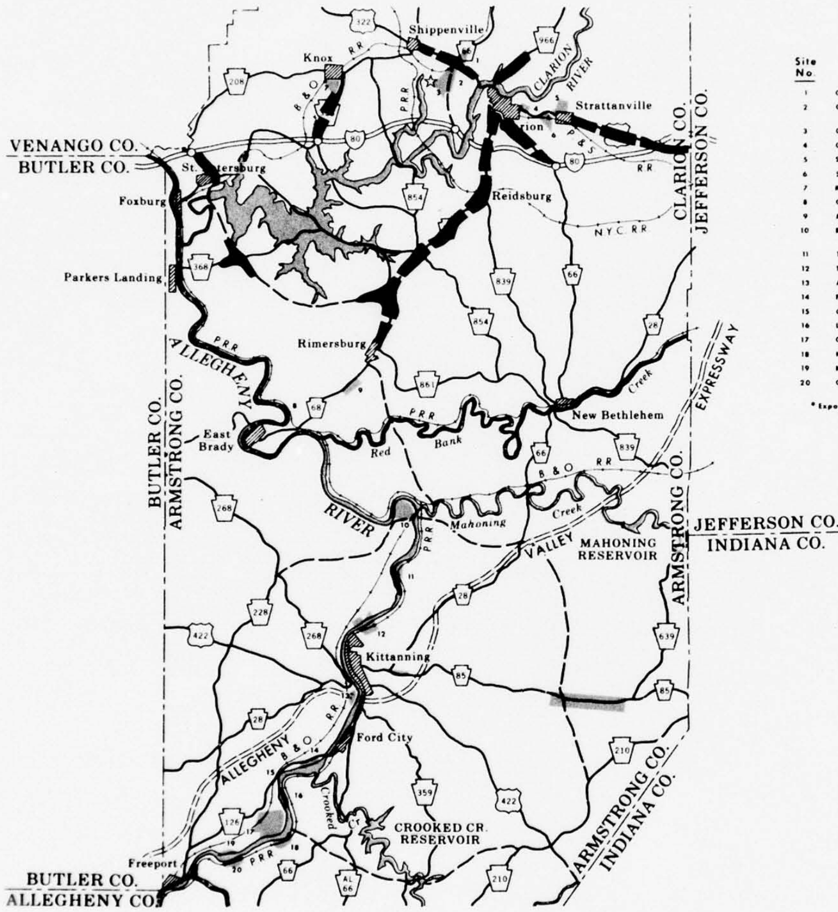
*/ Cost included in Table 11-22.

muskellunge and walleye. The presence and the population levels of these fish will depend upon suitable spawning sites and maintaining the water levels through the spawning periods, particularly for fishes of the pike and bass families. Consequently, if it is presumed that the regulated drawdown patterns will more or less affect fish population maintenance, and the movement of these fish upstream from the impoundment into the upper protected scenic river area, their most favorable adaptation can be assured by continuing studies of this type. It appears that the foregoing would be within the observations and intent of the Wild and Scenic Rivers Act, with the multiple-purpose impoundment developed below Cooksburg and the wild and scenic river developed above Cooksburg. Coordination regarding studies and operational procedures between management agencies of these river segments will be necessary to the realization of the most beneficial aspects of both.

Economic development objectives for optimization of the St. Petersburg site within the intent of Public Law 89-4 are discussed in preceding paragraphs, and in Chapter 12, Part II. These are summarized above in Section I. Basic principles relating to these objectives and to derivation of national and regional benefits, user and secondary, are discussed in the Main Report. A potential developmental plan which would be responsive to the objectives of the Appalachian Regional Development Act consists of a land use plan, including the possible location of industrial, commercial, and residential developments; and a transportation plan to service the foregoing and the project recreational areas and upstream river wild and scenic developments to the extent desirable within their objectives. These include a potential new highway routed from Interstate 80 across the dam, around the potential pumped-storage power site, surrounding the recreational and developmental areas on the south side of the project area, existing Interstate 80 along the north side of the project area, and both continuing into the vicinity of Clarion, Pennsylvania and upstream, plus other new and existing highways, existing and potential airports, and rail facilities pertinent to the economic and project developments. The latter would include a revitalized line of the Penn-Central Railroad from a hub in Clearfield County and passing through the potential development area on its course to Ashtabula on Lake Erie, and connection thereby to the megalopolis market areas, and to the export trade. The advantages and benefits of the development plan are discussed in Section V. The scope and expected effect of the plan for the purpose of benefit analyses is confined at this time to an appraisal of possibilities in contiguous Clarion and Armstrong Counties, Pennsylvania, related to or converging on the following growth center areas: the primary growth center along the lower Allegheny River at Kittanning-Ford City, the Clarion, Pennsylvania, secondary growth center, and the primary Ridgway-St. Marys growth center. These centers in essence extend respectively, from about the mouth of the Clarion River (Foxburg, Pennsylvania) to the intersection of the Allegheny-Armstrong-Butler County lines in the vicinity

of Freeport; and from the mouth of the Clarion River to above Clarion, Pennsylvania to the Clarion-Jefferson County line, then upstream to Ridgway. The analysis is relevant only to areas along the Allegheny River and the Clarion River as would be affected by goods and services of the potential water and related resources developments which attached to the Clarion River development at the St. Petersburg site. The plan of industrial and commercial development in outline is shown on Figure 11-6. Twenty sites involving about 2,230 acres of available land have been delineated. Employment of 7,070 persons is anticipated by the plan, with the chemical industry as the fulcrum of the study. Three Federal studies of economic development opportunities have been made in this area: Feasibility Study of Chemical Industry on Southwestern Pennsylvania 1/; A Tourism Facility Study of East Brady, Pennsylvania; 1/ and Appalachian Highlands Recreation Study, 1/. The first study reports in three phases were made by Singmaster and Breyer, New York, New York, for the Area Redevelopment Administration, U. S. Department of Commerce of which Report Phase III is dated September 1966. The study was made to determine the feasibility of additional chemical industry in southwestern Pennsylvania. The study after considering locational factors centered on Armstrong County, specifically a site on the Allegheny River at Reesedale, Pennsylvania, just downstream from the mouth of the Clarion River. The plan of development herein expands on this feasibility by adding to the means available for this industrial expansion, the resources of the Clarion River, including the St. Petersburg site. The second study is a survey made by Development Counsellors International, Ltd., New York, New York, for the Economic Development Administration, U. S. Department of Commerce, to determine the feasibility of both public and private recreation development for the East Brady, Clarion County, Pennsylvania area predicated primarily upon water related tourism. The third study is a cooperative venture by several Federal agencies, ten states, and the Appalachian Regional Commission to focus upon an area of Appalachia where recreation and related activities are fertile fields for future development. With respect to an optimum development, it was an objective of this study to recommend a strategy of recreational development that would benefit the people of the area in increased incomes and employment while, at the same time, would be compatible with national goals for the conservation and preservation of our scenic and natural resources. An Appalachian Regional Commission letter dated 19 December 1968 relevant to the St. Petersburg site potential is attached to this report. (See Exhibit 11-5.) This study also considered other local and state studies relevant to economic development, tourism and recreation in the area of interest as related to the project. Consideration of all of the available data indicates that the area and the St. Petersburg project site are in a favorable developmental position.

1/ On file in Pittsburgh District Office, Corps of Engineers, U.S. Army.



PLAN OF INDUSTRIAL DEVELOPMENT

Site No.	Location	Available Acreage	Type of Manufacturing	Employment
1	CLARION JUNCTION	200	TRANSPORTATION EQ	
2	CLARION JUNCTION	230	BOAT BUILDING * MOBILE HOMES	300
3	CLARION JUNCTION	125	APPAREL	300
4	CLARION	80	APPAREL	350
5	STRATTANVILLE	150	ELECTRIC COMPONENTS	500
6	STRATTANVILLE	100	FOAMED PLASTICS	100
7	KNOX	100	APPAREL	350
8	CATFISH	30	CELLULOS FIBERS	1400
9	MAPLE GROVE	200	ALUMINUM FABRICATING	1000
10	REESEDALE	145	ALUMINUM SMELTER SYNTHETIC ABRASIVES	450 420
11	TEMPLETON	100	PULP AND PAPER	340
12	TARRTOWN	100		
13	APPLEWOLD	75		
14	FORD CITY	100		
15	CADOGAN	75	CAUSTIC CHLORIDE	430
16	LOGANSPORT	50		
17	CLINTON	140	POLYVINYL CHLORIDE	430
18	KELLY STATION	50		
19	KNAPP RUN	140	CHEMICAL	700
20	GODFREY	40		

* Expansion of Existing Industry

ST. PETERSBURG RESERVOIR
CLARION RIVER, PENNSYLVANIA
A POSSIBLE DEVELOPMENT MAP

FIGURE II-6

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THE APPALACHIAN REGIONAL COMMISSION
1666 CONNECTICUT AVENUE
WASHINGTON, D.C. 20235

December 19, 1968

Lt. Colonel Wayne S. Nichols
District Engineer
Pittsburgh District, Corps of
Engineers
Department of the Army
Federal Building, 1000 Liberty Ave.
Pittsburgh, Pennsylvania 15222

Dear Colonel Nichols:

I am in receipt of your letter of December 10th, regarding recreation potential at St. Petersburg Reservoir. Our reference to the St. Petersburg Reservoir project as a terminal center in Table 9 of Phase I of the Highlands Recreation Study was made as a result of the inventory of facilities made by our office last March, as you may recall. From the data we received, an attempt was made to categorize the Corps of Engineers Reservoirs according to our study design. To make a possibly involved explanation short and direct, we felt that this Reservoir would offer another public facility that would act as a magnet to attract large volumes of recreationists--and as far as we are concerned, vacationers. It is our desire that continuation of the Highlands Study will further develop a picture of the feasibility of year-round vacation recreation.

St.Petersburg Reservoir could have a major role to play. Inasmuch as there are many values that might be disturbed by very intensive development at Kinzua and the Allegheny National Forest, the State Parks and other Corps of Engineers reservoirs surrounding the Forest (and private developments), should assume a role as focal points for the intensive type recreation, lodges, resort hotels, convention centers, etc.--that is, providing there is no conflict with Corps of Engineers and other public agency policies. (We will shortly be addressing ourselves to this question). From these areas, vacationers could, if they so desired, spend several days in the Forest wilderness camping, bird watching, canoeing, etc.

In addition to its possible role in the larger complex, the Reservoir area must be considered to have a very attractive role to play as an overnight stop off for travellers. Lodges, cabins, and motels, as well as camping areas, would appear to be applicable near the intersection with Interstate 80. Such facilities, in addition to

meeting needs of the transient public, could also serve as focal points for vacationists if major recreational opportunities would also be provided. A marina, golf course, etc., could be used by the traveller as well as the longer stay vacationist.

The complex we have generally defined is highly significant even at the present time according to visitation data submitted to us by the States, U. S. Forest Service, and Corps of Engineers. Cumulatively, the 29 public land facilities generated nearly 5.7 million visitations in 1967. Much of this useage can be termed day use as contrasted with longer stay vacation use. The day use feature has been necessitated in large part by the lack of overnight lodges and cabin facilities on public lands. Camping facilities are numerous and are continuously being added to.

The opening of the Pennsylvania Shortway should have an overpowering influence on the Complex. St. Petersburg Reservoir could be a major recreation ingredient in the overall complex if facilities are planned for both the vacation and transient recreation trade.

I don't know if these few remarks are of much help, but they may provide a little better insight about our assessment of the area.

Sincerely,

Neil M. Walp

Neil M. Walp
Regional Planner

NMW:mf

Detailed formulation of the project was initiated, with the above as background for project development, after correspondence and discussion with interested parties to establish common needs, objectives and goals, and after evaluating all of the potential economic, environmental, and aesthetic benefits. In this way, coordination was effected with Federal, State, Local and private interests to aid in the project and plan development. Research efforts by Clarion State College, Clarion, Pennsylvania, were solicited and obtained relative to economic impacts, water pollution evaluations, biological evaluations and observations supported by field investigations and studies of the river area and of the impoundment site. These were supplemented by other evaluations and data by the Clarion and Armstrong County Planning Commissions and by a report by Michael Baker, Jr., Inc. Consulting Engineers, Rochester, Pennsylvania, on the Foxview Development Plan which is a private development centered on the Golf Hall of Fame Museum and Golf Course (the oldest in continuous use in the United States) which will be located adjacent to the damsite and complement its development. The recreation plan contained in the latter part of Section III herein was formulated jointly with the Bureau of Outdoor Recreation to derive a unique plan for attraction of maximum visitation and at the same time to protect and preserve historical, archaelogical and natural environmental values. The Commonwealth of Pennsylvania, State Planning Board and Department of Commerce, by letters dated 19 January 1968, and 8 January 1968, respectively, approved the BOR plan and recreation evaluation.1/ An archaeological and historic site evaluation of the Clarion River Valley, initiated and supported by the National Park Service, was made of prehistoric and historic sites for the lower Clarion River Valley and for the reach between Cooksburg and Ridgway. The Western Pennsylvania Conservancy made field investigations, observations, and a report on the potential impoundment with the joint cooperation of BOR. The Pennsylvania Department of Highways prepared a special highway plan to integrate Interstate 80 and the impoundment and development area for realization of maximum economic development, including recreation. The Clarion County Planning Commission by letter dated 19 December 1968, 2/ considered alternatives concerning loss and replacement of housing units in the Callensburg-Sligo area. The development plan contemplates the possibility of using areas contiguous to the potential recreational and developmental sites for this purpose.

In the initial formulation, after weighing the factors and studies referred to above and the desires of all interested parties and the prospective benefits to the area, it was noted that concerned interests indicated that the highest summer conservation pool elevation would be the most suitable and beneficial for the project subject to certain protective criteria of which the most vital to project formulation is the limiting factor for the maximum pool elevation at Cooksburg and Cook Forest State Park at elevation 1160 MSL set by the Commonwealth of Pennsylvania. The limit is not detrimental to final formulation of project

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1/ Unpublished working draft.
2/ On file in Pittsburgh District Office.

purposes. Other considerations relate to protection of natural and other resources for recreation and conservation.

After selection of the site, the detailed formulation and sizing were developed from the following reasoning:

a. Because of the ideal location in the Allegheny River Basin for flood peak reduction, the flood control aspect of the reservoir was developed to its fullest extent. The summer flood control capacity is 4.5 in. and the winter capacity storage is 7.0 in., amounting to 64 percent and 100 percent respectively of the standard project flood runoff. This reservation of storage above the summer pool elevation of 1130 MSL results in a full pool elevation of 1155 MSL. Flood control capacity alone above a permanent pool of 0.2 in. capacity would result in a full pool elevation of about 1110, including freeboard.

b. Water quality control storage is dependent on the minimum allowable drawdown required to maintain the high aesthetic and recreational benefits. Any drawdown in excess of this minimum drastically reduces these benefits so that it is imperative that the summer pool remains at about elevation 1115 or higher. This restricted drawdown range enables the reservoir to meet the projected year 2020 water quality control needs as specified by the FWPCA for Pittsburgh, assuming that Rowlesburg Lake and other improvements outside the Clarion River Basin will be adding flow to meet the presently estimated requirements for low-flow augmentations.

c. The St. Petersburg site would control about 1,245 square miles of drainage area with a reservoir full elevation of 1155 and would provide effective storage for the water and related purposes of: (1) flood damage prevention; (2) hydro-electric power; (3) water supply; (4) water quality control; (5) general recreation and fish and wildlife enhancement; (6) inducement and support of economic development. This site provides for a much greater degree of flood damage prevention and sustained effect of its potential downstream reductions over a great length of the Allegheny and Ohio Rivers due to the larger drainage area controlled and its location in relation to the coincidence of Clarion River peak runoff with downriver peak runoff concentrations.

The preceding determinations for water supply and water quality control, hydropower, and recreational drawdown, along with other requirements, were made using a computer program with the following procedures.

a. The reservoir was theoretically operated for a period of record 1929 to 1966 using various flow schedules at Pittsburgh (Sewickley gage) and conventional or pumped-storage power outflows. The

studies were made to determine the maximum benefits other than recreational which could be attained by staying within the 15 foot maximum summer drawdown limitation, and within an additional 5 foot maximum winter drawdown limitation. Any additional drawdown after the summer recreation season which might be necessary for fall or winter augmentation is permissible, providing that the pool elevation 1110 is maintained, because spring runoff has always been in excess of that required for filling. A greater drawdown for severe drought conditions to draw on the storage between 1110 and the minimum pool elevation 937 is not conducive to recreation or productive of other benefits. However, in view of the relative infrequency of occurrence of such a dire emergency situation, it may be considered that with other system reservoirs equitably contributing to downstream low-flow requirements, drawdown would be permitted below elevation 1115-summer, and elevation 1110-winter. Operation for power would likewise be confined to this optimum recreation range, with occasional demands on drawdown in infrequent emergency situations.

b. In order to assure to the greatest extent a maximum summer drawdown of 15 feet, the preceding studies showed that, by using the year 2020 FWPCA low-flow schedule for Pittsburgh (Sewickley gage) and by halting or decreasing flow augmentation when elevation 1115 occurs until the recreation season is over, a high summer level could be maintained consistently. Under the most severe flow schedules of continuous daily releases of 1,200 cfs and 1,600 cfs. for water quality and hydropower development the optimal summer and winter pool levels can be reasonably maintained within the desired limits and yet maximize other purpose benefits. Figures 11-9, 11-10 and 11-11 in the drawdown discussion illustrate the range of summer and winter pool level extremes which such demands on storage would make, and the average interval of occurrence.

c. The reservoir was operated in a systems-operation with other existing and potential Allegheny River Basin reservoirs by varying the pattern of daily and weekly outflow, attempting to allow greater flexibility in meeting Allegheny River and Ohio River flow requirements for water quality and assimilation of wastes, particularly in a trade off arrangement with the existing Allegheny River Reservoir upstream at the Kinzua site, for more uniform releases for the upstream area. The objective was to stabilize water levels in the upper Allegheny River for fishing and other outdoor pursuits along both banks of the upper river in this vast recreational region covering 114 miles of river between Kinzua and the mouth of the Clarion River.

d. Releases from storage were analyzed also for deterring ice gorge formations from the mouth of the Clarion River at mile 84 to mile 58 between Dams 8 and 9 by release of higher temperature flows.

Supplementary to the above formulation factors, is the gorge-like character of the river valley throughout its reach to Ridgway, except for the broad and relatively level upland areas in the lower end of the impoundment site, especially in the Callensburg area, which are capped by higher levels which have been exploited by strip-mining for coal. The valley walls are steeply cut and relatively narrow across the valley until about elevation 1,070 is exceeded from which extend fairly broad plateaus of relatively flat slope, continuing to about elevation 1140. Land areas most conducive to best water-land relationships for recreational development are located at about the elevation range 1110-1130. Summer storage to elevation 1130 with subsequent level recession to about elevation 1110 in the winter provides concurrently a large amount of reservoir storage capacity and relatively large amount of land which can be devoted to shoreline and higher level recreational and other developments. Promontories and bays formed by storage to this water level range are numerous and interesting. Strippable coal reserves lie entirely above these levels forming a dual situation with regard to abandoned coal operations which need reclamation and active coal operations necessary to the immediate area economy. From the data indicated above, the levels of reservoir site consideration narrow to the increment between 1110 and 1160 to obtain maximum recreational balance and developmental opportunity and to provide for impoundment space for water supply, water quality and power storage, and space reservation for flood control. The space between 1110 and 1130 is best suited to recreation allowing reservation of space for 4.5 to 7.0 inches of flood control storage, summer and winter. The elevation 1160 State imposed limitation on the uppermost reservoir level would be attained at the Cooksburg area when the reservoir level would be at approximately elevation 1155. The full-pool, therefore, cannot exceed elevation 1155; however, conversely the required summer flood control reservation of 4.5 inches can be fitted into the elevation 1130-1155 gap; and the required winter flood control reservation of 7.0 inches can be fitted into the elevation 1110-1155 gap. The same amount of winter flood control storage reservation would require a full-pool level, with freeboard, at elevation 1110. The same considerations for storage space reservations for water supply, water quality and power would result in a minimum multiple-purpose full-pool at elevation 1144.

In relation to the computer program procedures, pumped-storage hydropower development possibilities at the St. Petersburg site were screened from studies conducted by the Corps of Engineers with the technical assistance of the Federal Power Commission.

The power plan selected for formulation from the various alternatives best suited for the project purpose, is the 420 megawatt pumped-storage installation (Plan "B", FPC ltr. 21 Dec 67) shown in Table 11-8 in comparison with other alternative possibilities. This plan would have the largest capacity and would be most responsive to power needs of the area. The table indicates that it would produce the greatest net benefits, and it would be most fully compatible with other

TABLE 11-8
SUMMARY OF HYDROELECTRIC POWER PLANS
CONSIDERED FOR ST. PETERSBURG RESERVOIR
(Physical Data)

Feature	PHYSICAL DATA Plan "A" FPC Letter, 31 July 1967 (Conventional Power)	Plan "B" FPC Letter, 31 July 1967 (Pumped Storage Power)	Plan "C" FPC Letter, 31 July 1967 (Pumped Storage Power)	Plan "A" FPC Letter, 21 December 1967 (Conventional Power)	BEST SUITED PLAN Plan "B" 3/ FPC Letter, 21 December 1967 (Pumped Storage Power)
Location:					
Stream	Clarion River	Clarion River	Clarion River	Clarion River	Clarion River
St. Petersburg Dam, river mile	5.0	5.0	5.0	5.0	5.0
Powerhouse, river mile	5.0	2.2	2.2	5.0	2.2
Reregulating Dam, river mile	0.3	0.3	0.3	0.3	0.3
Drainage area, sq. mi.	1,245	1,245	1,245	1,245	1,245
Type of Dam:					
St. Petersburg Dam	Concrete	Concrete	Concrete	Concrete	Concrete
Reregulating Dam	Concrete	Concrete	Concrete	Concrete	Concrete
Type of Spillway	Controlled ogee weir	Controlled ogee weir	Controlled ogee weir	Controlled ogee weir	Controlled ogee weir
Reservoir elevations, ft. above msl					
Top of dam	1165	1165	1165	1167.5	1167.5
Top of spillway gates	1144	1144	1144	1157	1157
Full pool elevation	1144	1144	1144	1155	1155
Maximum power or conservation pool	1110	1110	1110	1130	1130
Minimum power or conservation pool	937	937	937	1111	1111
Storage capacity, acre ft.					
Gross	840,400	840,400	840,400	981,300	981,300
Flood control, maximum	397,400	397,400	397,400	465,900	465,900
Power or conservation	495,700 1/	495,700	495,700	169,800 2/	169,800
Sediment and inactive	12,000	12,000	12,000	12,000	12,000
Power data:					
Installed capacity, MW	100	300	420	150	420
Dependable capacity, MW	100	300	420	150	420
Generation during critical load week, MWH	4,600	9,600	13,500	5,400	14,000
Generation during average load week, MWH	4,600	9,600	13,500	5,400	12,600
Average annual generation, MWH	240,000	500,000	700,000	280,000	650,000

1/ Storage between elevations 937 and 1110.
2/ Storage between elevations 1111 and 1130.
3/ The pertinent data shown for Plan "B" of FPC letter dated 21 December 1967 reflects the refinements made to the plan as a result of further study of the basic plan suggested by FPC.

TABLE 11-8 (Cont'd)
SUMMARY OF HYDROELECTRIC POWER PLANS
CONSIDERED FOR ST. PETERSBURG RESERVOIR
(Economic Data)

Item	ECONOMIC DATA Plan "A" FPC Letter, 31 July 1967 (Conventional Power)	Plan "B" FPC Letter, 31 July 1967 (Pumped Storage Power)	Plan "C" FPC Letter, 31 July 1967 (Pumped Storage Power)	Plan "A" FPC Letter, 21 December 1967 (Conventional Power)	BEST SUITED PLAN Plan "B" FPC Letter, 21 December 1967 (Pumped Storage Power)
COSTS					
1. First Cost 1/	$15,700,000	$33,300,000	$49,800,000	$20,300,000	$53,286,000
2. Investment	$17,000,000	$36,000,000	$53,900,000	$22,000,000	$64,292,000
3. Annual Charges					
Interest	$ 553,000	$ 1,170,000	$ 1,752,000	$ 714,000	$ 2,089,000
Amortization	24,000	50,000	75,000	30,000	89,000
Operation and maintenance	185,000	555,000	777,000	277,000	777,000
Major replacements	40,000	83,000	124,000	50,000	137,000
Pumping	--	1,040,000	1,820,000	--	1,638,000
Total, rounded	$ 802,000	$ 2,900,000	$ 4,550,000	$ 1,071,000	$ 4,730,000
4. Annual Cost of Alternate Power Plant 2/	$ 1,380,000	$ 3,700,000	$ 5,180,000	$ 1,910,000	$ 5,080,000
BENEFITS					
1. Average annual power benefits					
Capacity component 3/	$ 1,700,000	$ 5,100,000	$ 7,140,000	$ 2,550,000	$ 7,140,000
Energy component 4/	480,000	1,000,000	1,400,000	560,000	1,300,000
Total	$ 2,180,000	$ 6,100,000	$ 8,540,000	$ 3,110,000	$ 8,440,000
2. Net power benefits	$ 1,378,000	$ 3,200,000	$ 3,990,000	$ 2,039,000	$ 3,710,000

1/ First cost of all alternatives except the "Best Suited Plan" was determined by adding estimated engineering and design costs and supervision and administration costs to the cost estimate contained in the referenced FPC letters. The cost estimate of the "Best Suited Plan" is also based on the referenced FPC letter, but revisions were made as a result of more detailed consideration of this plan following the screening studies. The above figures for the "Best Suited Plan" reflect these revisions.

2/ Steam electric generating facilities. Annual cost based on $9.00 per kilowatt of dependable capacity and $2.00 per megawatt-hour of energy produced.

3/ Capacity component of benefits based on annual capacity value of $17.00 per kilowatt.

4/ Energy component of benefits based on annual energy value of $2.00 per megawatt hour.

formulated project purposes. These are based on water use withdrawal, water quality control and water supply, and other formulated project purposes which require stable drawdown reservations.

As previously noted, the projected needs for additional hydro-electric power in supply area No. 5 are high. Accordingly, in view of the potential market, the Federal Power Commission considers that power development at the St. Petersburg site be sized to maximize the power-producing potential.

Two factors are involved in this: (1) the site capability; namely, the opportunities for optimizing the size of the upper reservoir, and (2) the criteria for drawdown imposed to obtain maximum year-round recreation development and visitation. Studies of these two limiting factors are discussed in Section III with respect to the power operation. The maximum multiple-purpose full-pool at elevation 1155 would provide an installed capacity of 420 mw which would generate on the average year about 650,000 megawatt-hours. Comparably, the minimum multiple-purpose full-pool at elevation 1144, with an installed capacity of 300 mw, would generate 400,000 megawatt-hours; and a plan of doubtful structural and economic feasibility, with an installed capacity of 420 mw, would generate 700,000 megawatt-hours.

The formulation factors pertaining to the various purposes are reflected in the tabular analyses of the various heights of full-pool considered for maximizing net benefits, with the resulting combinations of multiple-purpose and single-purpose net benefit evaluations. The tabular data in Table 11-9 shows that for multiple-purpose development the net benefits increased from elevation 1144, the minimum possible, to elevation 1155, the maximum possible. The data indicates a substantial increase in net benefits from the lowest to the highest full-pool level. From net benefit evaluations, it was determined that a multiple-purpose reservoir is most productive of user benefits at full-pool 1155. The complementarity which the project furnishes for realization of optimum benefits for each purpose is covered in preceding discussions based on the computer programming for the year 1929 to 1966 period, which in turn is predicated upon operating the reservoir storage as depicted by the elevation-capacity and operation curves shown on Figures 11-7 and 11-8.

The summer drawdown restriction in a range of about 15 feet between elevations 1130-1115 would assure maximum net benefits for all purposes. Recreation optimum land and water levels are related to this range, as is 110,000 acre-feet of storage for water quality and water supply, and the water requirements for power generation. The project would meet needs for water quality in the Ohio River at Pittsburgh to year 2020. The 15-foot summer drawdown (1130-1115) required to furnish low-water and power flows would not affect the recreation user benefits which are anticipated at the amount established below for average summer pool

TABLE 11-9
Economic Evaluation of Alternative Projects
Having Various Combinations of Purposes
(Based on prices prevailing in July 1967)

Project 1/	Ave. annual benefits 2/	Ave. annual economic costs	Net benefits
Selected alternative:			
Multiple purpose project, Full pool el. 1155, Pumped-storage power, Plan B) 3/	$18,221,000	$12,225,000	$5,996,000
Other multiple purpose alternatives evaluated:			
Multiple purpose project, Full pool el. 1155 (Similar to selected alternative - except Plan A, conventional power development used.	12,500,000	8,520,000	3,980,000
Multiple purpose project, Full pool el. 1144 (Conventional power - Plan A)	7,912,000	7,612,000	300,000
Multiple purpose project, Full pool el. 1144 (Pumped-storage power - Plan B)	12,053,000	9,710,000	2,343,000
Multiple purpose project, Full pool el. 1144 (Pumped-storage power - Plan C)	14,668,000	11,360,000*/	3,308,000*/
Quad-purpose alternatives:			
FC, WS, WQ, R (less power)	9,288,000	7,449,000	1,735,000
WS, WQ, R, P (less flood control) Full pool el. 1130	15,742,000	11,115,000	4,627,000
FC, WS, R, P (less water quality)	16,869,000	12,211,000	4,658,000
FC, WS, WQ, P (less recreation)	13,002,000	10,661,000	2,341,000
Tri-purpose alternatives: 4/			
WS, R, P (less FC, WQ), Full pool el. 1130	14,590,000	11,102,000	3,488,000
WS, FC, R (less WQ, P), Full pool el. 1148	7,938,000	6,796,000	1,142,000
FC, R, P (less WS, WQ), Full pool el. 1130	16,869,000	12,211,000	4,658,000
WQ, R, P (less FC, WS)	15,742,000	11,115,000	4,627,000

TABLE 11-9 (CONT'D)
Economic Evaluation of Alternative Projects Having Various Combinations of Purposes (Based on prices prevailing in July 1967)

(Continued)

Project 1/	Ave. annual benefits 2/	Ave. annual economic costs	Net Benefits
Dual-purpose alternatives: 5/			
R, P (less FC, WQ, WS), Full pool el. 1130	$14,590,000	$11,102,000	$3,488,000
Single purpose alternatives:			
FC, Full pool el. 1106	2,516,000	3,358,000	842,000
R, Full pool el. 1120	4,348,000	2,740,000	1,608,000
P, (federally financed steam plant)	8,440,000	5,080,000	3,360,000
WQ, (single purpose WQ reservoir on Clarion River)	1,350,000	1,350,000	-

*/ Not definite due to long power tunnel uncertainities (Plan C).

1/ Full pool el. is considered to be at 1155 unless otherwise indicated.

2/ Includes redevelopment benefits in national account, also land enhancement benefit of $920,000 is included as a benefit except where recreation is excluded as a project purpose in which case it is dropped entirely as a benefit.

3/ Includes flood control, water supply, water quality, hydroelectric power, recreation and land enhancement as project purposes. Only a token storage has been included for water supply and no benefit has been claimed for this purpose.

4/ Other combinations involving recreation and power were not evaluated as these two purposes give a high ratio of benefits in relation to costs and it can be seen by inspection that their elimination will not maximize the net benefits.

5/ After analyzing the tri-purpose alternatives in comparison with the selected plan it became readily apparent that the only dual-purpose project with any possibility of giving maximum net benefits would be a dual purpose recreation-power reservoir and this therefore was the only dual purpose project evaluated.

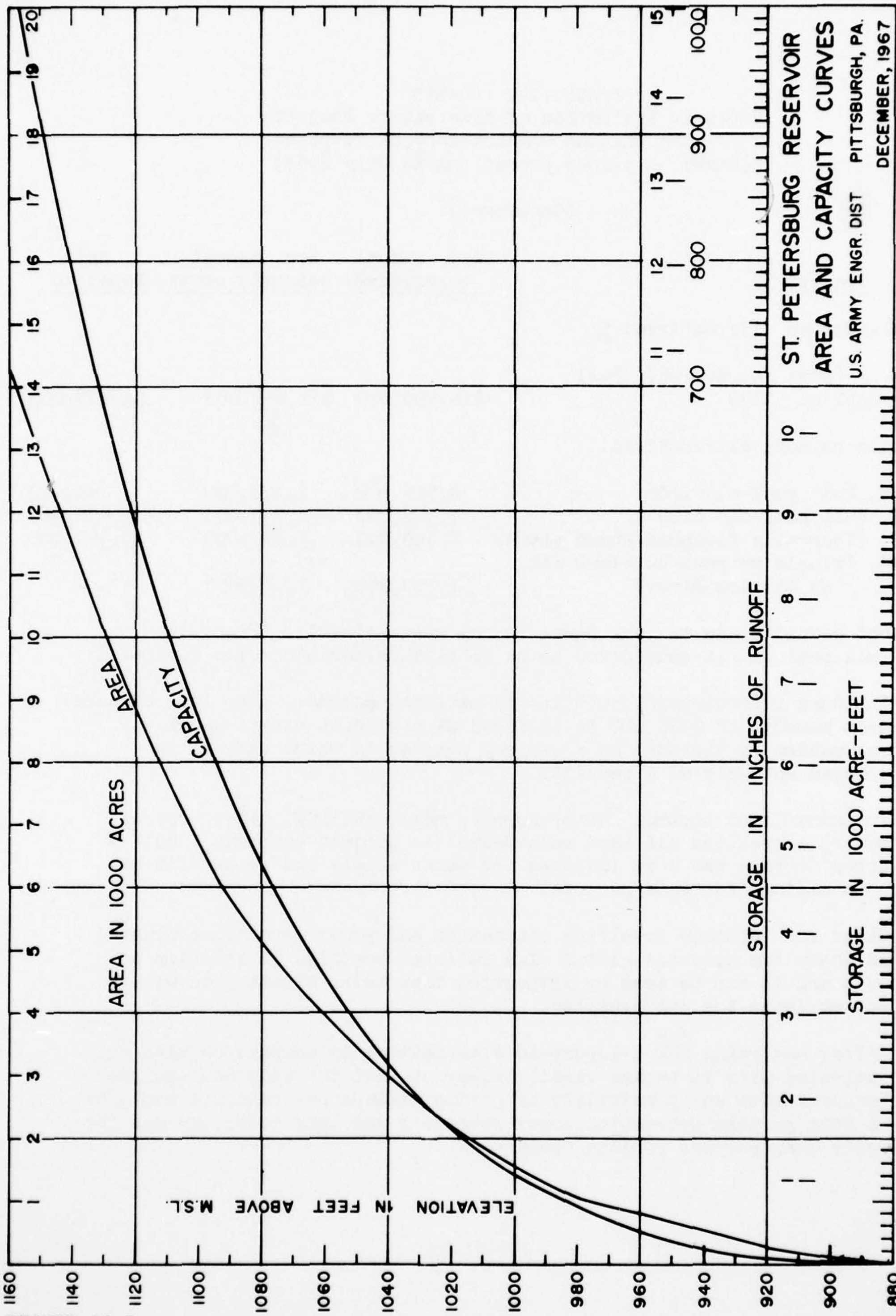

ST. PETERSBURG RESERVOIR
AREA AND CAPACITY CURVES
U.S. ARMY ENGR. DIST PITTSBURGH, PA.
DECEMBER, 1967
AREA IN 1000 ACRES
ELEVATION IN FEET ABOVE M.S.L.
STORAGE IN INCHES OF RUNOFF
STORAGE IN 1000 ACRE-FEET
AREA
CAPACITY

FIGURE 11-7

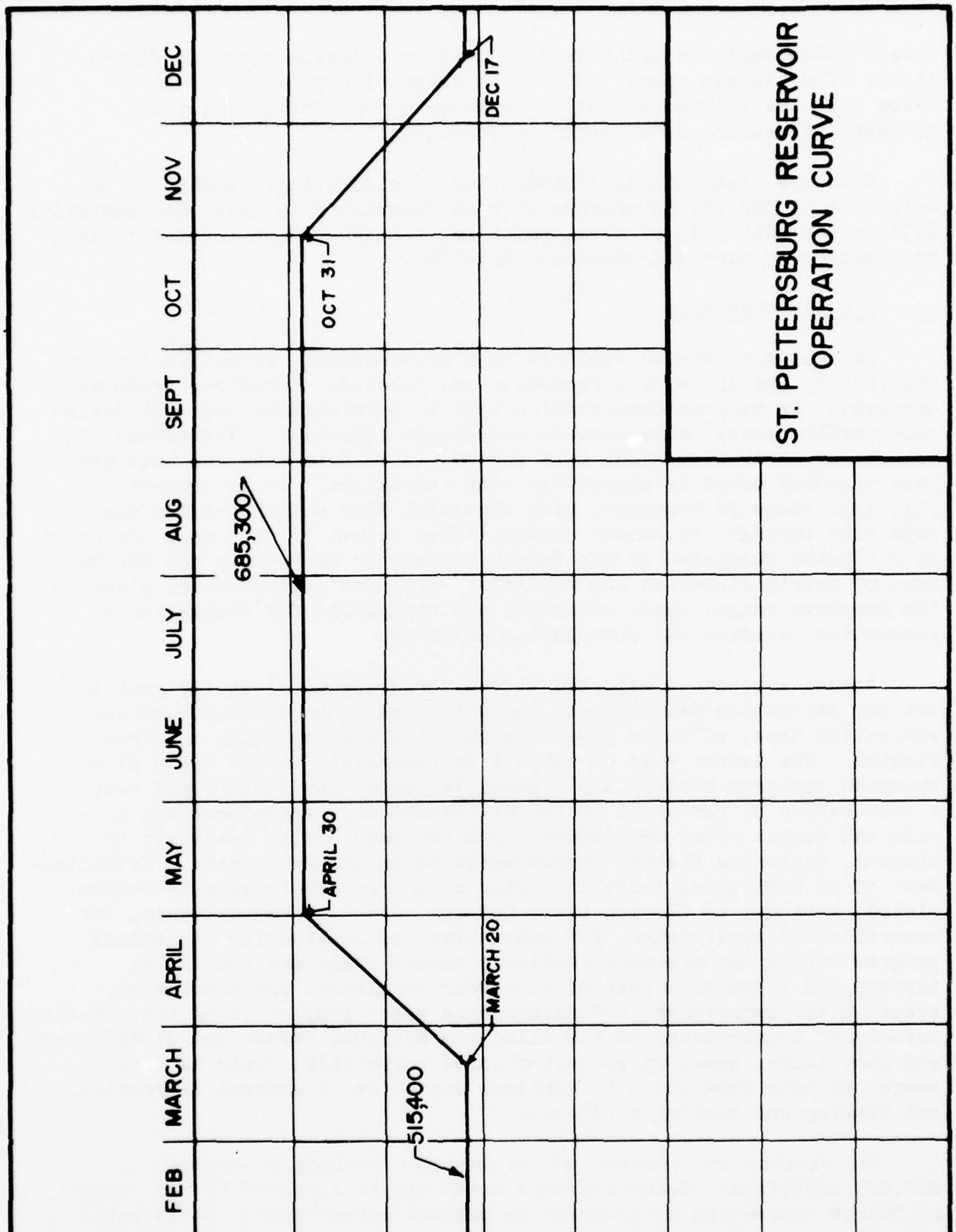

ST. PETERSBURG RESERVOIR
OPERATION CURVE
JAN
FEB
MARCH
APRIL
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
515,400
MARCH 20
APRIL 30
685,300
OCT 31
DEC 17
700
600
500
400
300
200
100
STORAGE — 1000 AF

FIGURE II-8

levels which would be maintained to month-end levels shown in Figure 11-11. The minimum summer and winter recreation pool levels at or below 1115 and 1110 would not be exceeded except infrequently as discussed elsewhere under drawdown conditions.

With due regard to all formulation considerations, potential development of the St. Petersburg site as formulated to full-pool elevation 1155 is the best plan of development for the sub-region for the fullest realization of user and expansion benefits.

Annual Attendance

Estimates of annual visitors to a multi-season recreation complex confined to the envisioned reservoir and lakeside recreation areas were developed for various conservation levels, particularly the most desirable developmental range between elevations 1115-1130. Visitation values for lower elevations were considered to determine the most desirable drawdown schedule compatible with recreation. For the elevation 1115-1130 range of drawdown, with elevation 1130 maintained the maximum time through the summer season, total annual visitor days are based on estimates furnished by the Bureau of Outdoor Recreation and the Bureau of Sports Fisheries and Wildlife. With due consideration given to the drawdown range, these estimates are reasonable for evaluation of recreation benefits for formulation purposes.

Annual attendance expected at the formulated project for general outdoor recreation development, was estimated to be 3,529,000 annual recreation days, of which 169,000 recreation days annually are from fishing. The latter will be subject to reanalysis on the basis of an improved upstream fishery and a possible downstream fishery and with a combination of resources of the St. Petersburg impoundment and a wild and scenic river development from the head of the reservoir to Ridgway, including fishery improvements on tributary streams. Establishment of an ecological research center at the reservoir site is contemplated, attached to Clarion State College, Clarion, Pennsylvania, for expertise and supervision, for exhaustive and imaginative biological program during the pre-construction planning stage and continuing through and becoming a part of reservoir regulation and associated scenic river improvement and maintenance after completion of construction. Associated improvements on the Allegheny National Forest and State forest and game lands, based on project-related potentials, could also be a source of data from which to consider expansion of general recreation and fishing and hunting visitation.

The visitor day estimate shown does not include an estimate of 260,000 additional recreation days which may be expected as the result of future recreation development by private investments. It is estimated that the 16,000 acres of general outdoor recreation land included in the plan will induce and support public and private investments and

public and privately operated facilities envisioned for ultimate general outdoor recreation development. Attendance for the total project area and as affected by induced fringe area developments by private investments may be considered in future estimates. BOR has indicated that non-Federal administration of the public outdoor recreation development would be appropriate. Vigorous advertising could be expected on this basis, with full consideration given to recreation year-round as an industry, and resultant higher visitation than presently estimated.

Drawdown

Demands for withdrawals for water supply and water quality, and hydropower were computer analyzed. Individual and combinations of withdrawals for the existing system at 1980 (with Rowlesburg Lake in operation) were computer analyzed to establish critical drawdown relationships and interrelationships. These computer analyses of reservoir operation indicated that the projected flow requirements needed for water quality control on the Ohio River at Sewickley could not be met with the existing system, using the system to its full capability. On this basis, 110,000 acre-feet was reserved for water quality control in the St. Petersburg site, to be applied to deficiencies which would be indicated at the Sewickley gage to meet the FWPCA 1980-2020 projected flow needs nine of ten years. Power withdrawals for generation of 650,000 mwh annually at an installed capacity of 420 mw on the average would require a daily outflow of about 1,200 cfs, depending upon providing an adequate size upper reservoir, of about 14,000 acre-foot capacity at a top level at about elevation 1350. Recreation requirements for full development and maximum visitation are based on the restricted regulation range from 1130 to 1115 in the summer and to elevation 1110 in the winter.

Tables 11-10 and Table 11-11 illustrate hypothetical drawdown at the end of each month in the summer, June-September, inclusive, for the 1929 to 1966 period of record for two individual withdrawal requirements for low-flow augmentation and for power. Figures 11-9 and 11-10 are a hypothetical operation for the period of record showing requirements individually for water quality and power. For water quality alone and for power alone, shown by the tabular data and the solid and dash lines on the figures (assuming for the most critical case that low-flow augmentation would not be halted or curtailed when elevation 1115 would be reached), it is noted from the computer runs that: for low-flow augmentation for projected water quality needs to 2020, drawdown during the summer and winter to meet water quality flow requirements of varying magnitude for the projected 2020 schedule would produce fluctuations of the water level in the reservoir (solid-line) which would assure full realization of water quality benefits; and (assuming for the most critical requirements that power generation would not be restricted when elevation 1115 is reached), it is noted also that: drawdown (at average rate of 1,200 cfs) during the summer and winter for maximum power generation would yield fluctuations of water level (dash-line) which would likewise assure full power benefits.

TABLE 11-10

RECREATION SEASON DRAWDOWN - LOW FLOW AUGMENTATION REQUIREMENT

Drawdown, in feet, below top of conservation pool level (elev 1130) at end of month shown

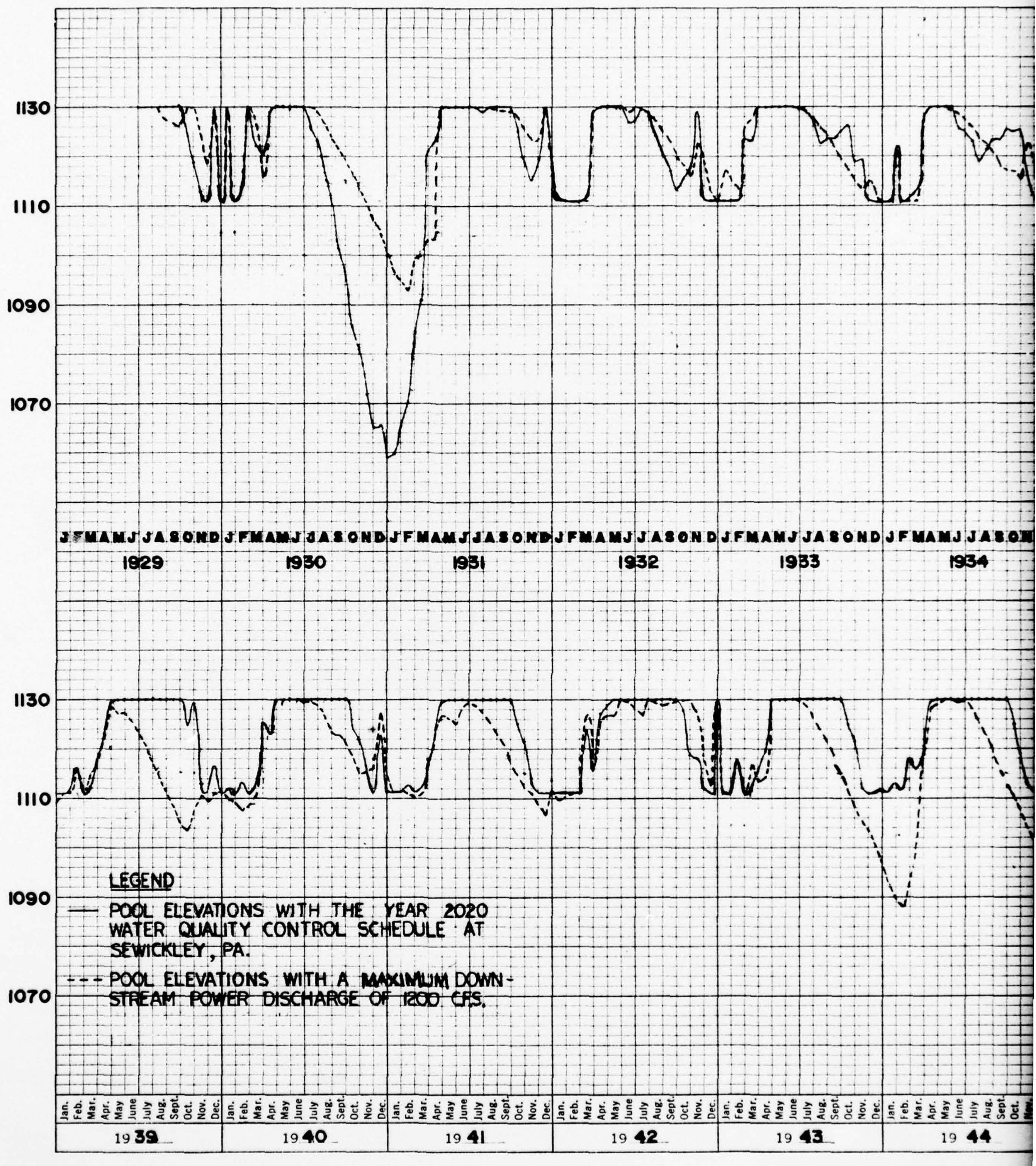
Year	June	July	August	September	Year	June	July	August	September
1929	0	0	0	0	1948	0	0	0	0
1930	0	7	18	34	1949	0	0	0	0
1931	0	1	0	0	1950	0	0	0	0
1932	3	1	10	16	1951	0	0	0	0
1933	0	3	6	5	1952	0	1	0	0
1934	5	11	7	4	1953	0	0	0	0
1935	0	0	0	0	1954	0	0	0	0
1936	0	3	2	0	1955	0	0	0	0
1937	0	0	0	0	1956	0	0	0	0
1938	0	0	0	0	1957	0	1	4	6
1939	0	0	0	0	1958	0	0	0	0
1940	0	0	0	0	1959	0	0	10	12
1941	0	0	0	0	1960	0	0	0	0
1942	0	0	0	0	1961	0	0	0	0
1943	0	0	0	0	1962	0	2	6	4
1944	0	0	0	0	1963	0	1	0	0
1945	0	0	0	0	1964	0	0	0	0
1946	0	0	0	0	1965	0	8	11	6
1947	0	0	0	0					

TABLE 11-11

RECREATION SEASON DRAWDOWN - POWER REQUIREMENT

Drawdown, in feet, below top of conservation pool level (elev 1130.0) at end of month shown

Year	June	July	August	September	Year	June	July	August	September
1929	0	0	2	4	1948	0	2	5	10
1930	0	1	6	11	1949	3	8	14	20
1931	0	0	0	1	1950	1	0	2	1
1932	0	1	5	10	1951	0	2	7	13
1933	0	2	6	10	1952	3	8	14	21
1934	2	7	10	13	1953	1	3	1	1
1935	0	0	0	1	1954	1	4	8	12
1936	0	4	6	11	1955	4	7	11	16
1937	0	0	0	2	1956	0	0	0	0
1938	0	0	2	3	1957	0	5	12	19
1939	7	12	18	25	1958	0	0	0	0
1940	0	2	7	9	1959	0	1	4	8
1941	0	2	7	13	1960	0	1	5	9
1942	2	0	1	0	1961	0	0	2	5
1943	0	4	9	15	1962	2	6	10	14
1944	0	5	11	17	1963	1	4	8	12
1945	0	0	2	0	1964	3	6	8	13
1946	0	2	6	11	1965	2	6	10	11
1947	0	3	7	10					


1130
1110
1090
1070
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N
1929
1930
1931
1932
1933
1934
1130
1110
1090
1070
LEGEND
POOL ELEVATIONS WITH THE YEAR 2020 WATER QUALITY CONTROL SCHEDULE AT SEWICKLEY, PA.
POOL ELEVATIONS WITH A MAXIMUM DOWN-STREAM POWER DISCHARGE OF 1200 CFS.
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1939
1940
1941
1942
1943
1944

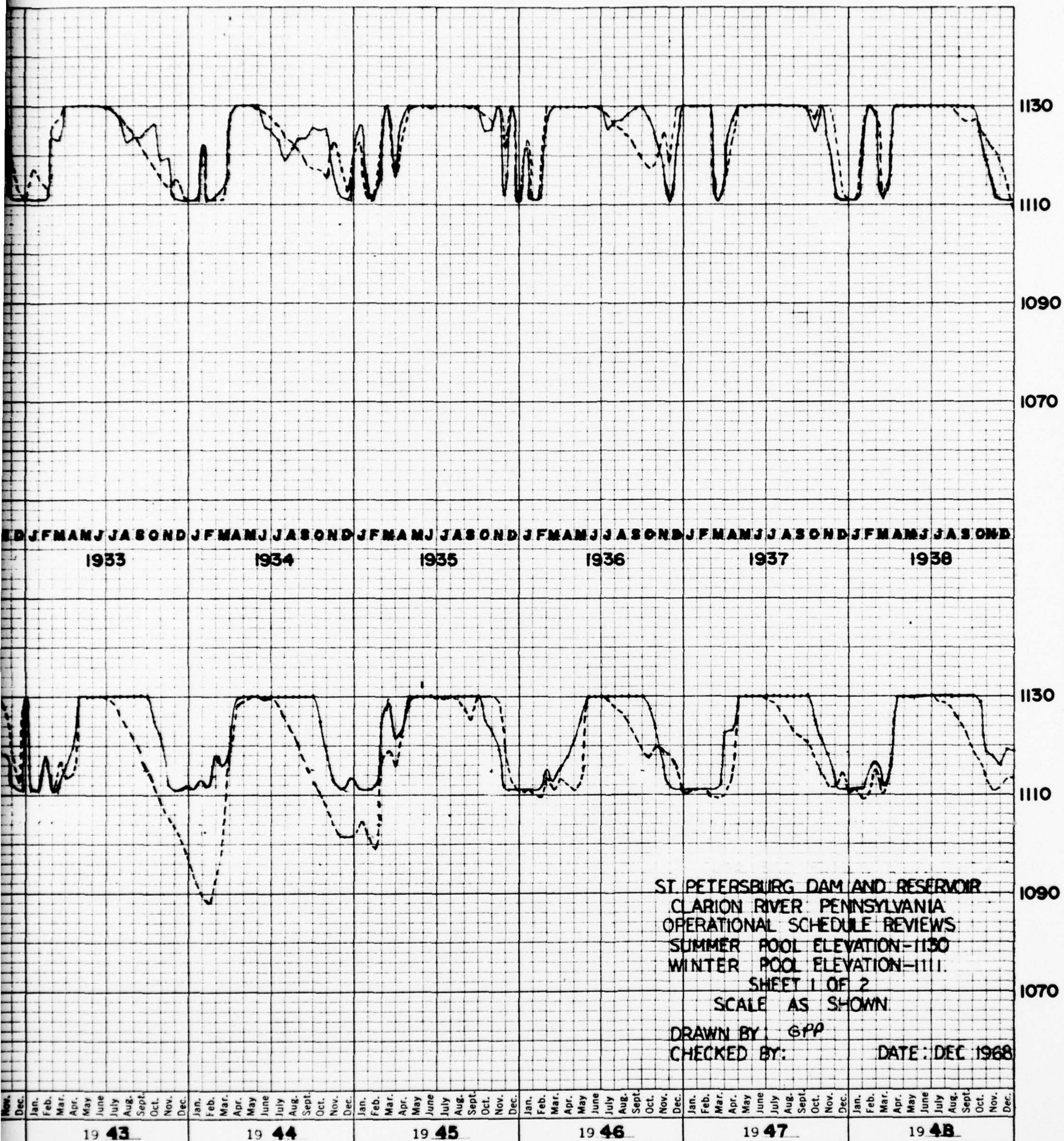
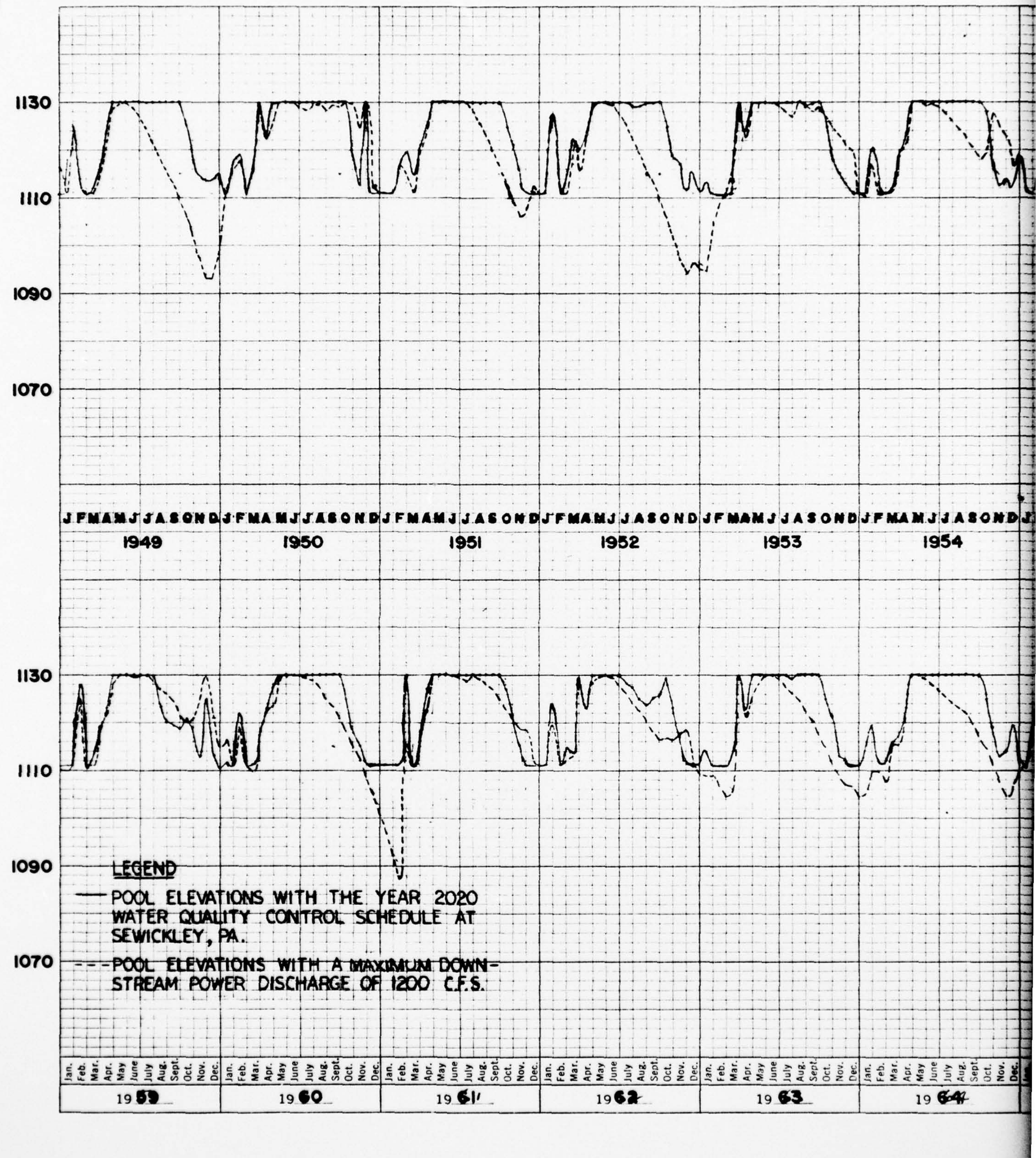

1130
1110
1090
1070
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
1933
1934
1935
1936
1937
1938
1943
1944
1945
1946
1947
1948
ST. PETERSBURG DAM AND RESERVOIR
CLARION RIVER PENNSYLVANIA
OPERATIONAL SCHEDULE REVIEWS
SUMMER POOL ELEVATION-1130
WINTER POOL ELEVATION-1111
SHEET 1 OF 2
SCALE AS SHOWN
DRAWN BY: GPP
CHECKED BY:
DATE: DEC 1968

FIGURE 11-9



1130
1110
1090
1070
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1949
1950
1951
1952
1953
1954
LEGEND
POOL ELEVATIONS WITH THE YEAR 2020 WATER QUALITY CONTROL SCHEDULE AT SEWICKLEY, PA.
POOL ELEVATIONS WITH A MAXIMUM DOWN-STREAM POWER DISCHARGE OF 1200 C.F.S.
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1959
1960
1961
1962
1963
1964

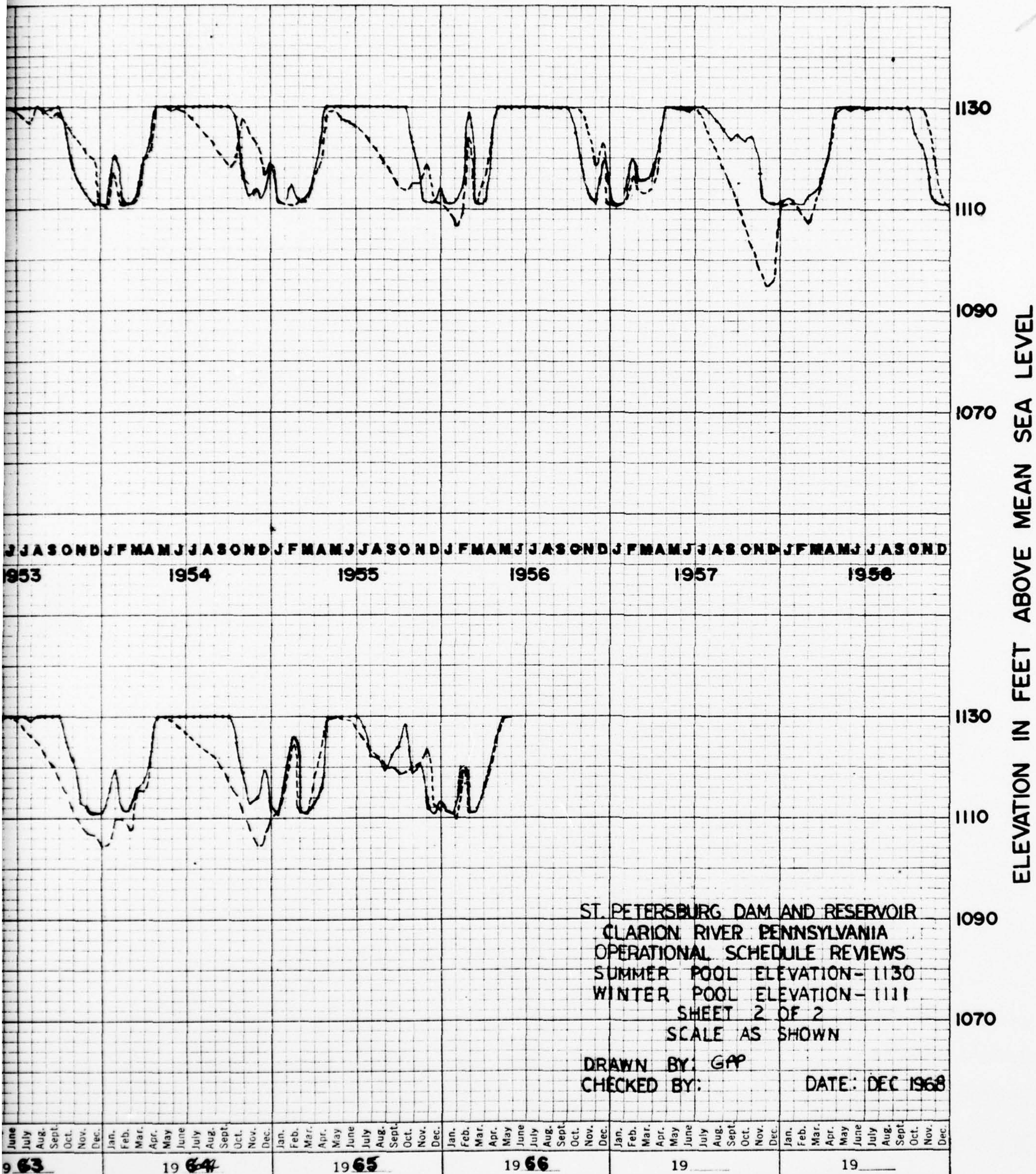

1130
1110
1090
1070
J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1953
1954
1955
1956
1957
1958
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
ST. PETERSBURG DAM AND RESERVOIR
CLARION RIVER PENNSYLVANIA
OPERATIONAL SCHEDULE REVIEWS
SUMMER POOL ELEVATION- 1130
WINTER POOL ELEVATION- 1111
SHEET 2 OF 2
SCALE AS SHOWN
DRAWN BY: GAP
CHECKED BY:
DATE: DEC 1968
June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1963
1964
1965
1966
19
19

FIGURE 11-10

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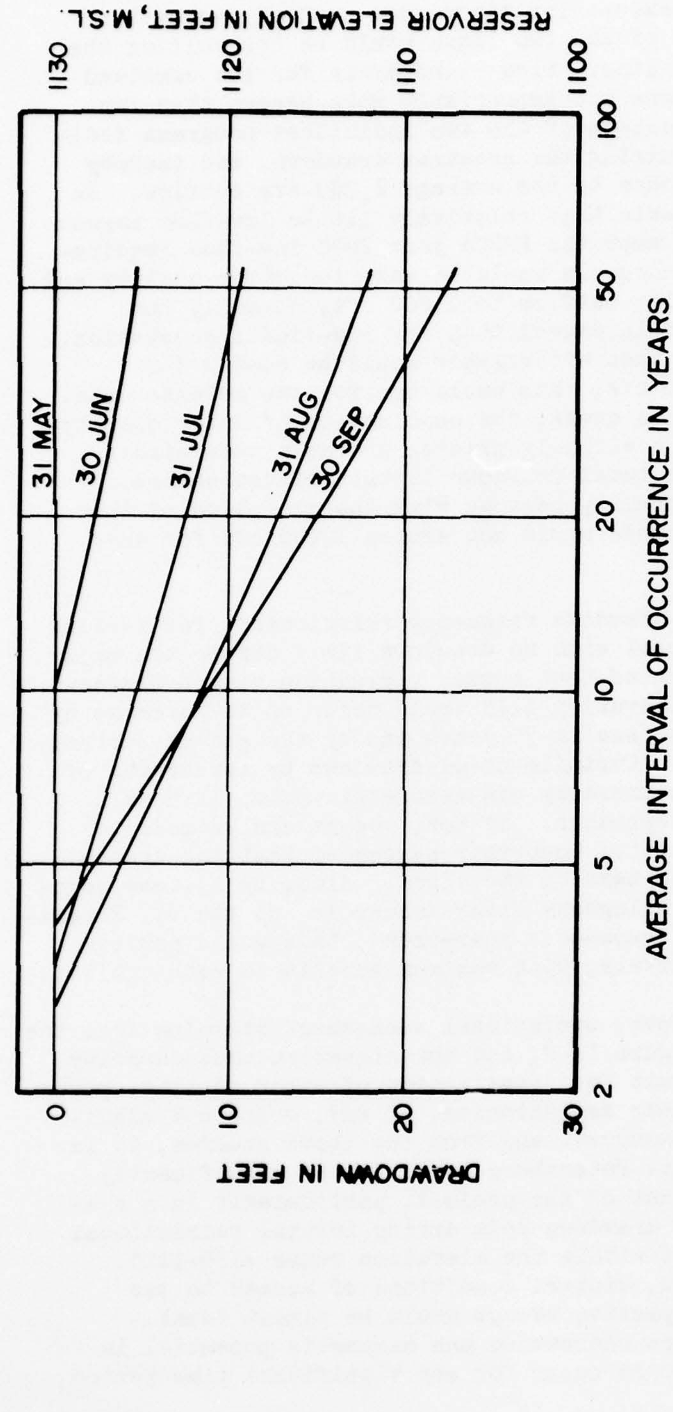
With either case, full recreation benefits would be realized. By combining these requirements, except for times when nominal regulation criteria prevail, the lower of the two lines would be controlling the succeeding levels of either line. Flow withdrawals for the combined situation discussed below were not appreciably more severe than for the individiual cases. Comparison of the two individual programs indicates that the schedule requiring the greatest drawdown, and thereby the larger withdrawal, attaches to the average 1,200 cfs outflow. In many years, the program reveals that relatively little low-flow augmentation would be required to meet the FWPCA year 2020 low-flow requirements. Therefore, when withdrawals would be made for water quality and pumped-storage power, limiting outflow to 1,200 cfs, normally the pumped-storage withdrawal would exceed that for low-flow augmentation. On the infrequent occasions when withdrawals would be needed for Sewickley in excess of 1,200 cfs, this would control the release rate. Where the solid and dash-lines cross, the combination of water quality and power needs may produce a slightly greater drawdown than either individual requirement. The total drawdown in this situation could still be controlled satisfactorily because with the exception of the year 1930, water quality demands would not exceed 1,200 cfs for any appreciable time durations.

Figure 11-11 shows the drawdown frequency relationship for various levels of the conservation pool with no drawdown limit during the major recreation season. It indicated that summer recreation season drawdown exceeding 15 feet to below elevation 1115 would occur on the average by the end of August only about once in 30 years and by the end of September only about once in 20 years. Curtailment of drawdown by assessment of low-flow and power needs concurrently can assure elevation 1115 as a minimum through the end of September. If not, resort can be made to proration of demands on the total reservoir system so that the system would probably be required to take up the slack. Also, by systems-regulation between the existing Allegheny River Reservoir and the St. Petersburg site, with appropriate trade-offs year-round, this would achieve this same objective alternatively, with maximum benefit to each project.

In essence, from the above, operational management stemming from the nominal regulation curve, Figure 11-8, and the elevation-area-capacity curve, Figure 11-7 would permit full realization of water quality, power and recreation benefits. Minor deficiencies, if any, would not significantly affect drawdown procedures, and from the above studies, it is concluded that drawdown at St. Petersburg would not be significantly detrimental to full development of the project, particularly in a systems-pool. Consideration of drawdown made during initial recreational formulation, established that within the elevation range 1130-1115, summer, and to elevation 1110, winter, conditions of access to the reservoir water and its prospective useage would be almost ideal.
An indication of the excellent recreation and aesthetic potential is that little or no drawdown would occur for any significant time period,



CURVES INDICATE AVERAGE INTERVAL OF OCCURRENCE OF DRAWDOWN AT, OR GREATER THAN VALUES SHOWN. THESE CURVES ARE BASED ON THEORETICAL 5-DAY AVERAGE FLOW OPERATION FOR THE PERIOD 1929-1966, WITHOUT ANY CONSTRAINT ON DRAWDOWN.

RECREATION SEASON
DRAWDOWN FRQUENCY
ST. PETERSBURG RES.

FIGURE 11-11

except in a rare emergency drought situation. Facility design and location for public and private investments could be arranged to offset any detrimental drawdown effects on recreation or conservation values. Shoreline perimeter roads are not contemplated in the formulated project.

Further discussion of environmental values, including general outdoor recreation, and scenic river evaluations, presents the unique and outstanding potential of the total envisionment of the Clarion River Basin with the excellent potential of enhancement of the total environment by inclusion of the St. Petersburg site development as an integral part. Development and management of these resources by cooperation of Federal, State, local governmental and private interests can assure an outstanding economic development effort based upon the proposed framework of major project purposes with a combination of intensive recreational development complementary to the area's inherent natural scenic and conservation values.

9. SELECTED PROJECT

A multi-purpose reservoir at St. Petersburg emerged from these formulation studies as the water resource improvement capable of satisfying the most identified needs at the least cost.

The St. Petersburg Reservoir area is shown on Figure 11-12. The dam would be concrete with a maximum height of 288.5 feet. The spillway would have an ogee weir and would be controlled by 7 tainter gates 45 feet wide and 27 feet high. The outlet works would consist of six sluices through the spillway at streambed elevation and one water quality control sluice in the left abutment adjacent to the spillway. The water quality control sluice would be used to discharge warmer water from the upper level of the reservoir for public use purposes. The reservoir would be 30 miles long and have an area of 10,140 acres at elevation 1,130, the maximum summer pool. Project purposes would include flood damage prevention, hydroelectric power generation, water supply, water quality control, water-based recreation, and economic development.

The improvements will significantly reduce flood damages along the Allegheny and Ohio Rivers in Sub-region F. Substantial reductions would also occur along the Ohio River in Sub-region G. It will meet the needs for additional flow at Sewickley, Pennsylvania, for water quality control to the year 2020. The project will also satisfy a substantial portion of the electric power and water-based recreation needs of the area. In addition to meeting the above present needs, the St. Petersburg project would provide the necessary water supply to meet the needs of the economic expansion expected to result from project construction.

The St. Petersburg Reservoir would be operated by the Federal Government as a combined flood control, recreation, hydropower, and low-water regulation (for water quality and water supply) project,

in conjunction with other similar projects in the upper Ohio River Basin. Only by a coordinated operation of all facilities could the maximum benefits from these comprehensive purposes be realized. Greater flexibility of operation would be possible under the coordinated system with the St. Petersburg Reservoir added. The potential reservoir would provide control of an additional 10.6 percent of the Allegheny Basin drainage area, and a storage capacity of nearly one million additional acre-feet in the upper Ohio River Basin. This storage and control would allow for substantial flexibility of operation of the total reservoir system by permitting exchanges and trade-offs of water uses between reservoirs. This would allow for a more efficient and effective operation of the existing reservoir system in the upper Ohio River Basin. A highly significant recreational development would be provided to the sub-region for release of its population from highly urbanized pressures, and as inducement to the location of investments in the reservoir area and downstream areas with unique and outstanding cultural values for the attraction of industry and a highly trained and capable labor force.

Section III following contains a full description of design considerations pertinent to the St. Petersburg site development, including discussions of environmental aspects, hydropower potential, acid drainage abatement and land reclamation, and economic development as related to project design.

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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)

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2 OF 5

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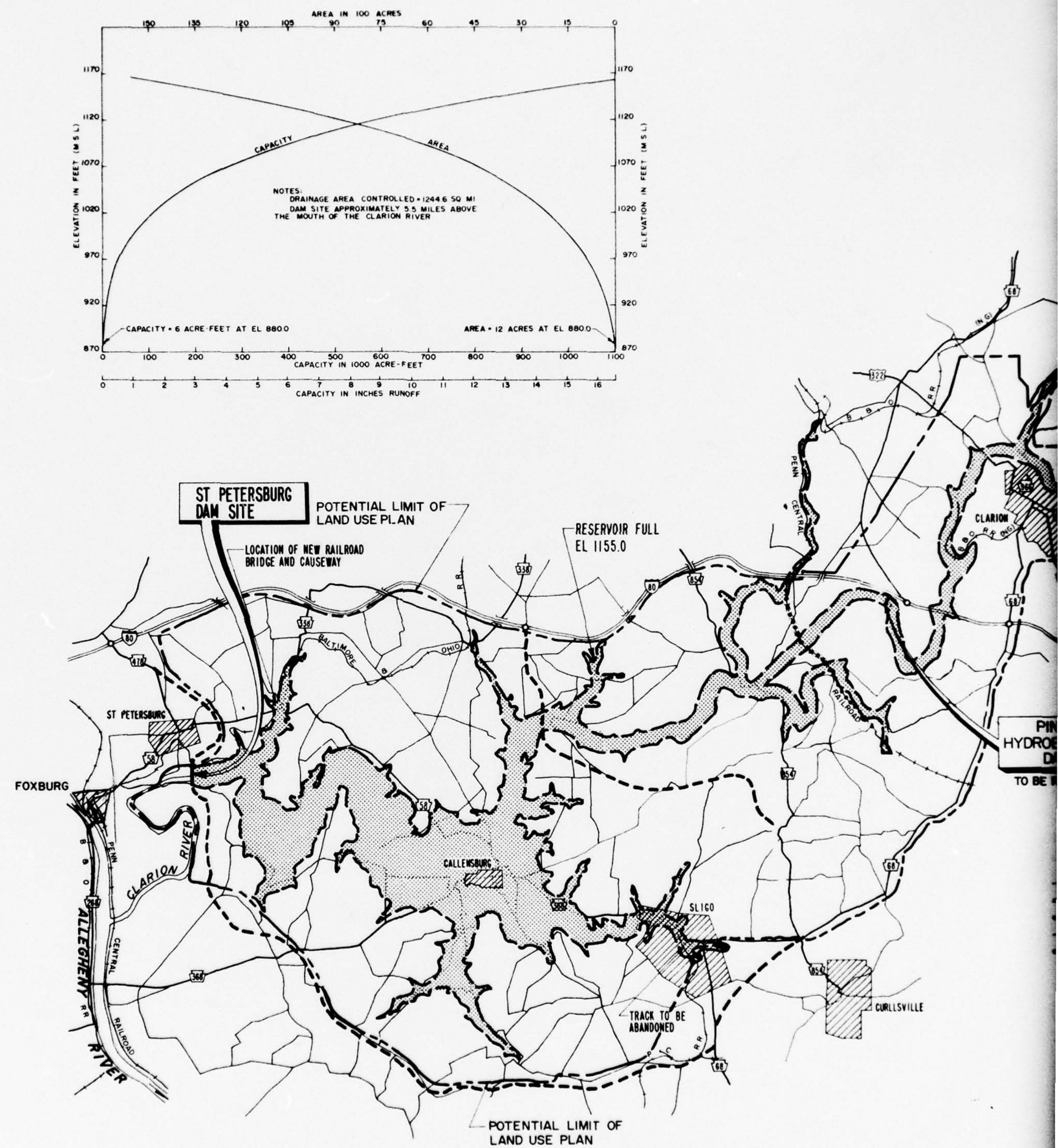
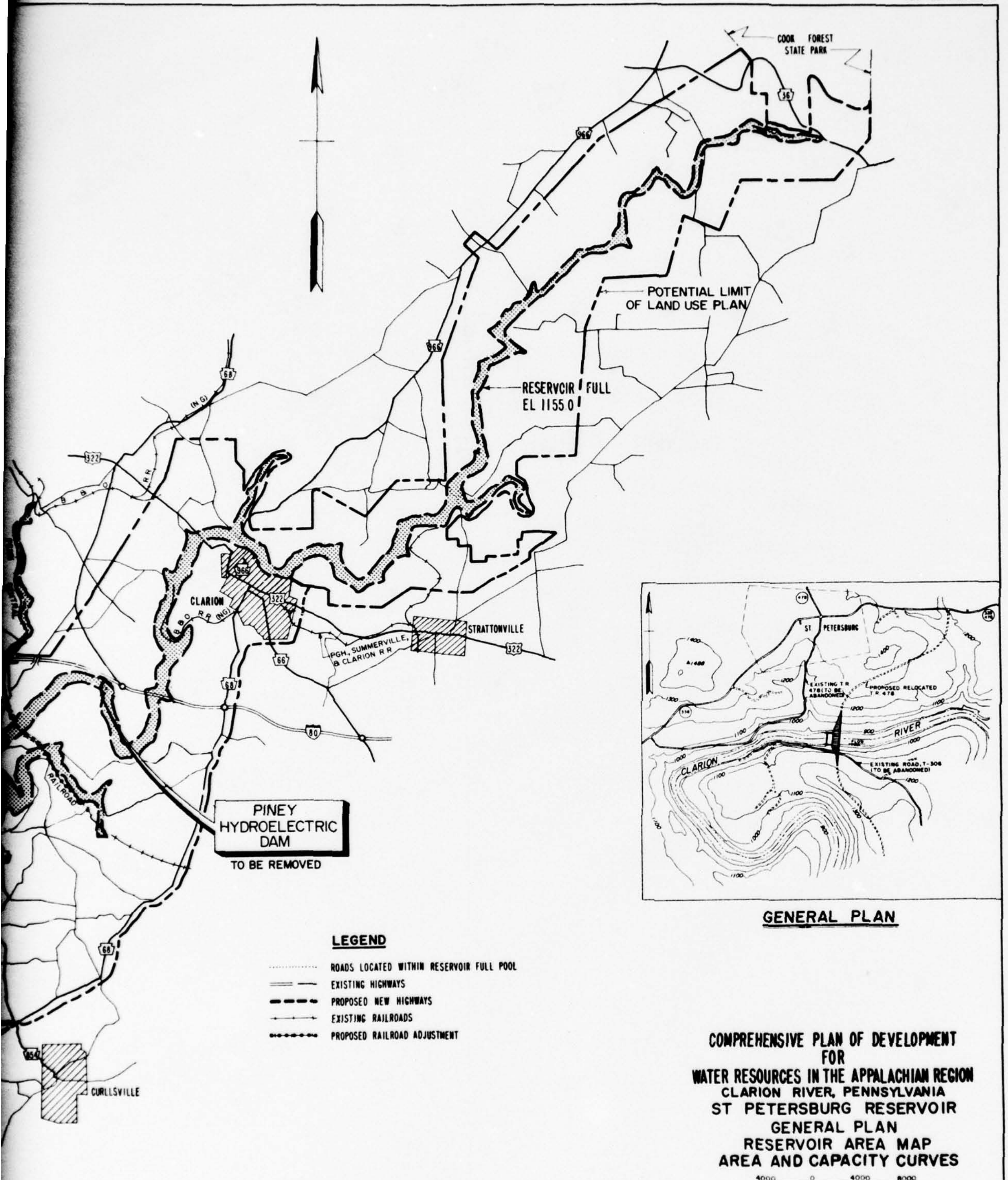

AREA IN 100 ACRES
150 135 120 105 90 75 60 45 30 15 0
ELEVATION IN FEET (M S L)
1170 1120 1070 1020 970 920 870
CAPACITY
AREA
NOTES:
DRAINAGE AREA CONTROLLED = 1244.6 SQ MI
DAM SITE APPROXIMATELY 5.5 MILES ABOVE THE MOUTH OF THE CLARION RIVER
CAPACITY = 6 ACRE-FEET AT EL 880.0
AREA = 12 ACRES AT EL 880.0
0 100 200 300 400 500 600 700 800 900 1000 1100
CAPACITY IN 1000 ACRE-FEET
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
CAPACITY IN INCHES RUNOFF
ST PETERSBURG DAM SITE
POTENTIAL LIMIT OF LAND USE PLAN
LOCATION OF NEW RAILROAD BRIDGE AND CAUSEWAY
RESERVOIR FULL EL 1155.0
ST PETERSBURG
FOXBURG
CLARION RIVER
ALLEGHENY RIVER
PENN CENTRAL RAILROAD
BALTIMORE & OHIO
CALLENSBURG
SLIGO
CURLLSVILLE
CLARION
TRACK TO BE ABANDONED
POTENTIAL LIMIT OF LAND USE PLAN
TO BE



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
CLARION RIVER, PENNSYLVANIA
ST PETERSBURG RESERVOIR
GENERAL PLAN
RESERVOIR AREA MAP
AREA AND CAPACITY CURVES

FIGURE 11-12

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SECTION III

DESIGN CONSIDERATIONS

10. INTRODUCTION

Analyses are presented below in detail to identify and develop the hydrology, geology and ecology of the proposed St. Petersburg Dam and Reservoir Project and the Clarion River, and other pertinent natural and physical factors which relate to water-resource purpose requirements for storage (impoundment); structural; feature concept, and other needed design considerations, and the costs for these necessary items.

Established procedures and methodology and data appropriate for the project purposes are indicated where and in the manner they are used to firmly establish the project purposes and their method of accomplishment to meet significantly critical (or constraining) water and related resource needs of the sub-region, without an excess in cost over any other feasible alternative. Requirements for relocation and real estate involvements are estimated realistically for extent and cost in accordance with accepted standard practice, and special provisions are indicated where these illustrate cost savings over standard methods. Significant environmental quality considerations are specified with discussion of alternative solutions for developing and managing the project area's and the Clarion River region's water and related land resources, and such coordination of various planning groups are specified which will improve the project area and implement the project purposes. Included in these is a plan of recreation development based on the quantity and quality of the project area's environmental factors and the aesthetic qualities and use of water and land areas to alleviate deficiencies of the project area and the sub-region for environmental quality improvement and recreation (in view of the large unfulfilled need to provide recreation) to mitigate economic problems and to induce economic growth in the surrounding rural and highly urbanized areas which form the bulk of the market area for the project's water resources goods and services and natural (scenic) amenities. A devised program is presented also as a project prerequisite and coordinated with the Commonwealth of Pennsylvania and interested Federal agencies for acid mine drainage abatement and land reclamation, to assure an impoundment whose water quality will meet State and Federal requirements and will derive maximum benefit from the multiple-purposes of the project. The above are all given significant analysis and are specifically documented within the context of available reliable data and current and proposed study and development programs in the project area.

11. HYDROLOGIC

Resume

Analyses in detail of the hydrologic characteristics of the Clarion River Basin, the Clarion River, and the reservoir site are discussed and

evaluated for critical conditions that must be anticipated in order to properly formulate the project and determine its most efficient hydraulic and dimensional design to best fit the multiple-purposes which the project is intended to furnish. Structural and other design considerations are related to Corps of Engineers standard hydrologic procedures. Actual and hypothetical analyses based on these standards and data of record support the project conception and formulation. Basic hydrologic data underlying structural and other project feature design procedures derived from these are shown for the best project formulations. It is contended that an adequate hydrologic base exists to guarantee efficient performance of the proposed project.

General Basin Climatology

The climate of the basin is predominantly continental, strongly influenced by meteorological attributes of the Great Lakes and Appalachian Mountains. Summers generally are mild and winters cold, with expectation of occasional, extremes of both. Precipitation of the Basin is considered adequate for the best formulation of project purposes. Gradual weather changes which predominate, interspersed by seasonably rapid passages of fronts associated with air mass convergence, form hazardous flood producing runoff to the Allegheny River and the Ohio River Basins, as evidenced by the historical climatic and storm data, and analyses below.

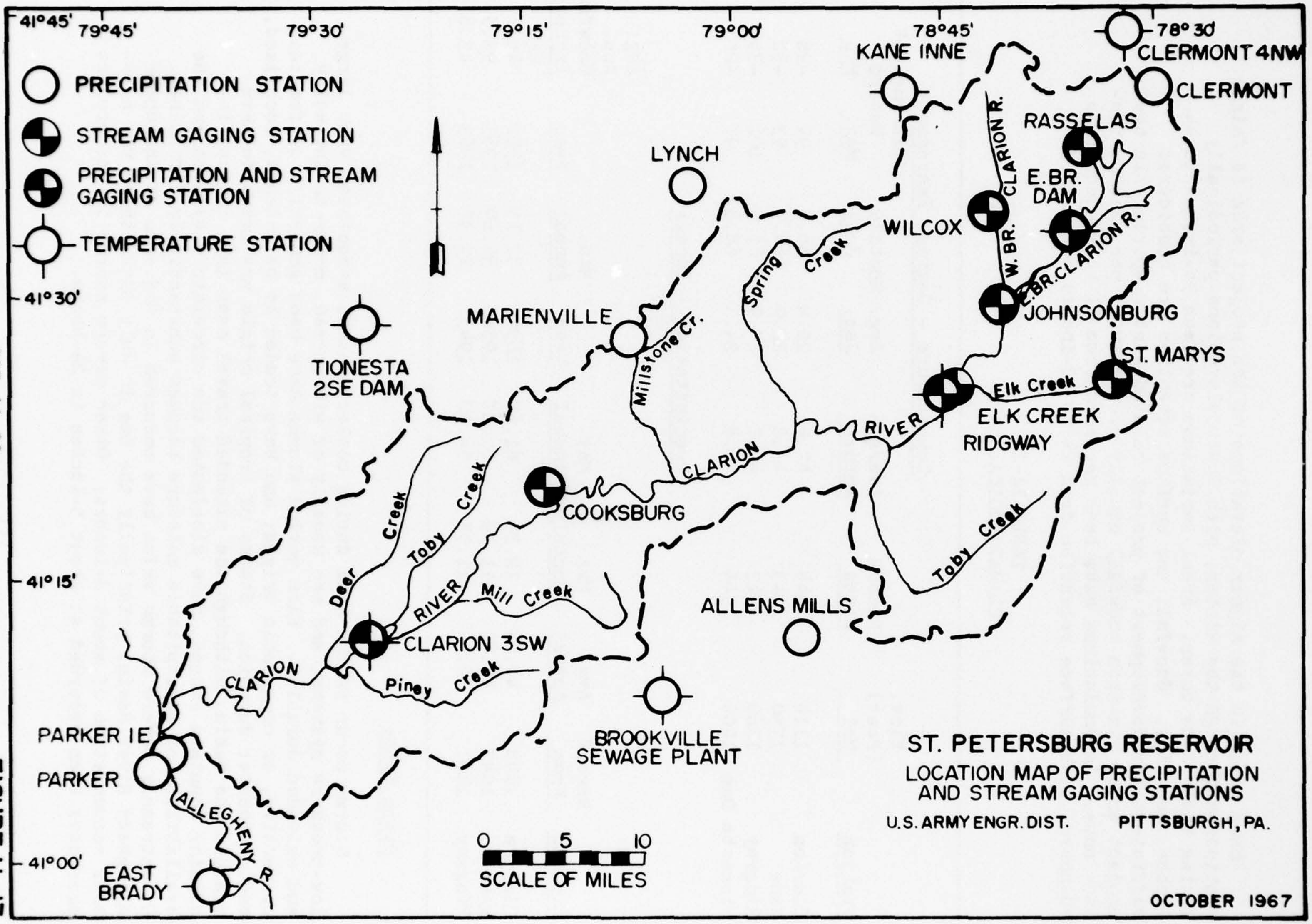
Climatological Records

Four U. S. Weather Bureau stations record climatic data in the Clarion River Basin and surrounding area. These recording stations are located as depicted on Figure 11-13. Synopses of recorded data related to 25 or more years of record are shown and analyzed below.

Average annual temperature for the basin is about 47 degrees, varying with topographic elevation.

Recorded data for seven stations, including the recording stations, within the Clarion River Basin indicate that past average yearly precipitation amounted to about 43 inches. Generally, however, little locational variance occurs even with mountains to the east. Variations from about 40 to about 46-inches, reflect orographic effect of station elevation differences. Annual distribution of precipitation is favorably disposed to sustaining the seasonal ecology demands of the area and at the project. Minimum monthly precipitations near zero have been recorded. Of the three stations located spatially, two have over 50 years of continuous record.

Locations of climatological stations are also depicted on Figure 11-13.



ST. PETERSBURG RESERVOIR
LOCATION MAP OF PRECIPITATION AND STREAM GAGING STATIONS
U.S. ARMY ENGR. DIST. PITTSBURGH, PA.
OCTOBER 1967

FIGURE 11-13

Snow cover in the higher elevations of the project area is fairly continuous through the winter, with lower elevations periodically losing their snow cover. Areal variations are from 94-inches to 44-inches, annually. Snowfall and surface retention are considered sufficient for development of project related winter sports. In the project area, six-inch snowfall usually occurs twice per season, ten-inch once. Accumulations have been recorded from 11 to 24-inches in 48-hours; with surface retention from 24 to 42-inches per season.

TABLE 11-12
CLIMATOLOGICAL DATA

			Temperature - Degrees Fahrenheit				
	Elev. (Feet)	Record	Average	Avg. Monthly		Extremes of Record	
Station	Msl	Began	Annual	Jan.	July	Max.	Min.
Clarion	1114	1944	47.6	25.4	68.8	99	-26
Kane	1750	1943	43.8	22.0	64.9	93	-32
Ridgway	1360	1913	46.7	24.9	67.9	101	-35
Tionesta Dam	1200	1944	46.8	24.3	68.8	97	-28

				Precipitation - Inches				
Station	Record From	Avg. Annual	Max. Monthly	Max. Annual	Year	Min. Annual	Year	Avg. Ann. Snowfall Inches
Clarion	1888	44.09	12.36	61.62	1890	32.15	1962	46.1
Kane	1943	45.81	11.19	61.87	1956	34.89	1963	93.5
Ridgway	1887	39.64	11.57	54.92	1945	29.37	1963	43.8

Storm Types

Storms occur in the area during cooler months, associated with large low-pressure systems, and are usually of widespread, moderate intensity, and extended duration. Warm period storms have been generally of frontal, convective, or orographic origin; and have tended tc be intense, localized, and of shorter duration. Storms of tropical origin are known to have reached the basin, although the extended travel over land masses, including mountain ranges, have dissipated the circulatory systems and the availability of precipitable moisture becomes substantially diminished. Of extremely severe storms which have occurred in the area of the upper Allegheny River Basin, principally the one in July 1942, there was a 24-hour accumulation of about 8-inches. Other severe storms in the project area have been recorded at about 5-inches in 24-hours.

Major Experienced Storms

Storms which have produced floods of record on smaller drainage areas of the basin have been of the convective type, and ordinarily quite localized. The major summer-type storm of July 1942 produced precipitation up to 35 inches, from which record flooding occurred in the upper Allegheny and Genesee River Basins and extended over some of the tributaries of the Upper Susquehanna River. A widespread, persistent storm system happened in March 1936; the accompanying influx of warm air of the storm system caused rapid melting of heavy snow cover and with coincident intense rainfall, measuring up to six inches, generated the flood of record on the Clarion River as measured at Cooksburg.

Initial Losses and Infiltration

Analyses of rainfall and runoff records made to evaluate losses of storm rainfall into the soil mantle of Clarion River Basin and the project area, reflect those conditions in the area which affect loss rates such as climatological conditions, areas strip-mined for coal, and geological and environmental characteristics studied and reported on by FWPCA, USGS, USBM, USDA and others, including soil texture, groundwater, land slopes, and condition of vegetative and other cover of the project area. Initial losses during colder months have been noted to be negligible due to frozen soil, saturated soil, and high water tables, and to increase up to about one inch during drier summer periods. Infiltration rates have been variable, from nearly zero during the winter months to about 0.3 inch per hour during summer months. These are considered in unit hydrograph determinations below for the Clarion River at the project site.

Unit Hydrograph

Floods were selected and analyzed in unit hydrograph studies which would permit use for satisfactory simulation. Unit hydrograph coefficients derived from these analyses were adopted for derivation of synthetic unit hydrographs at the project site. These are employed with factors below to derive and scope project features and facilities.

Runoff

Runoff data collected in the sub-region by the Corps of Engineers, U. S. Army; U.S. Geological Survey; and U.S. Weather Bureau indicates an average annual runoff upon which to base the multiple project purposes which has basin variation from about 23.0 to 24.5 inches. Larger seasonal variations have been recorded at times at the stations of record. About 56 percent of precipitation can therefore be considered as runoff available for project development and operation.

TABLE 11-13
RUNOFF DATA

Stream and Station	D.A. (Sq.Mi.)	Years of Record	Annual Mean.	Runoff Max.	(in.) Min.	Gage Datum (m.s.l.)	Stage (ft.)	Maximum Known Flood Discharge (cfs)
W. Branch Clarion R. Wilcox	63.0	14	24.6	39.8	19.9	1502.02	10.01	5,490
Clarion R. Johnsonburg	204	22	24.2	35.7	18.4	1422.98	8.83	8,530
Clarion R. Cooksburg	807	29	23.4	34.8	16.1	1146.48	12.09	20.700
Clarion R. Near Piney	951	43	22.9	34.9	12.9	1002.06	Modified by Piney Dam	

River Basin Characteristics

The Clarion River Basin is one of the largest tributaries to the Allegheny River, entering at about Mile 84, from the left bank. The basin overall is elongated, having a northeast-southwest orientation, and receives drainage from a total of 1,249 square miles. Controlled drainage area above the proposed damsite would be 1,245 square miles. Topographic elevations vary from about 2,300 feet in the north-eastern basin limit to 850 at the river mouth. Local relief ridge to stream is generally about 300 to 500 feet. Valley sides are steep at the river edge, with levelling to moderately sloped plateaus and intermediate land above.

Natural stream channels are stable and well defined, generally flowing on rock beds. Primary river bank heights on the main stream vary from three feet in its upper reaches to 20 feet or more downstream. However, at some downstream locations there are abrupt, canyon-like, rises of 400 to 500 feet from the very edge of the river. Tributary banks vary in height from about two to 15 feet. Generally, flood plain widths range from less than 500 feet to 1,500 feet. Main stream slopes are fairly regular, varying in a range between about 40 to 70 feet per mile. Periodic series of shallow, small-stone riffles generally flow to about one-foot depth, with longer eddies three feet or more in depth. The total riverbed ascent is about 500-feet from Ridgway to the mouth. Tributary flood plains are generally narrow.

Existing Reservoir Storage and Effect on Project Development

Runoff in the basin is partially controlled by two impoundments: the existing East Branch Clarion River Reservoir, operated and maintained by the Corps of Engineers, and the Piney Hydroelectric Power Project. The East Branch reservoir project controls a drainage area of 72.4 square miles, and is used for flood control and low-flow augmentation purposes at Johnsonburg on the Clarion River. The minimum flow releases provided at Johnsonburg, based on weighted water temperature, have varied seasonably from 80 to 220 cubic feet per second. Total storage capacity of the reservoir is 84,300 acre feet, representing 21.84 inches of controlled local basin runoff. Of this total, 19,000 acre feet, or 4.92 inches, are reserved for summer flood storage. Winter flood control storage reservation is 38,700 acre feet, or 10.03 inches. With 1,000 acre feet of permanent storage, this leaves potentially 64,300 acre feet, or 16.66 inches of storage for satisfaction of low-flow augmentation needs, and for flow into the scenic river reach from Ridgway to Cooksburg.

Piney Dam and Reservoir is located in the basin and is a hydroelectric project privately owned by Pennsylvania Electric Company. The dam lies about 25.5 miles above the mouth of the Clarion River. Stream bed elevation is about 1,000 feet above mean sea level. It is provided with 14 tainter gates, 25 feet wide by 18 feet high, for release of flood runoff in excess of turbine capacity. The tops of the gates are at elevation 1,093, with a computed maximum capacity at this level, when fully open, of about 100,000 cfs. Total reservoir capacity at elevation 1,093 is 33,800 acre feet. Peak load power generation usually results in reservoir drawdown of one to five feet to augment the daily flows.

The 12 mile reach of existing Piney Lake submerges the natural river channel with valley sides falling steeply into the lake. Because of these steep hillside banks, the lake is very inaccessible for recreational use. Consequently, with only two highway crossings and a few other isolated points of access, its overall recreational use is restricted to boat docks at the foot of precipitously sloping roads, and cottage developments which hang haphazardly along these.

Operations of the Piney power dam also have a very deleterious effect on the flows and use of the Clarion River below it. During the summer months when tributary natural stream flow is low, power can only be generated at most 5 days a week. When power is not being generated, at off-peak times, the river below the dam is nearly dry. Shortly before noon each day of power generation turbine outflow usually raises the river 4 to 5 feet. Wave movement through the valley takes about 10 hours, thus producing a severe restriction on day use. The river has 2 road crossings within this reach and it is possible to canoe during the

afternoon on the power wave. Since water is withheld from the river below the dam on Saturdays and Sundays, use of this reach of the river is diminished for canoeing enjoyment. In this reach of the river hillsides generally rise immediately from the banks with only minimal terracing and small overflow areas. Scenic enjoyment of this winding wooded valley is considered as limited to rapid canoeing from the power damsite to the river mouth on the waves issuing from the penstocks.

Existing Channel Improvements

Height of residual flood crests at Johnsonburg and Ridgway are somewhat locally modified by existing Corps of Engineers' channel improvements. The Johnsonburg project begins at the confluence of the East Branch and the West Branch, and extends up the West Branch for a distance of about 0.5 mile to Silver Creek, and about 0.3 mile up Silver Creek. The Ridgway project extends in the Clarion River for better than 2 miles and continues up Elk Creek from a new cutoff channel for a distance of about 1.1 miles.

These projects would not affect project formulation for multiple-purposes.

Storage Reallocation, East Branch Clarion Reservoir

Existing East Branch Clarion Reservoir storage allocation and low water release schedule have been developed for nearly maximum water conservation use. With annual precipitation of about 42 inches, annual runoff to the reservoir is about 20.7 inches. Within the 15 year period of reservoir operation the minimum annual runoff has been 17.8 inches. Much dryer years are known to have occurred prior to construction. The summer reservation of 4.92 inches for flood control storage is considered necessary to control recurrence of past, high summer regional floods.

Storage of 16.66-inches for low water regulation represents a very small margin of capacity over annual runoff. In the drought years of 1930-1934 the reservoir would have been drawndown to minimum permissable level. In a normal year pool drawdown is about 29,000 acre feet by mid-September, or about 46 percent of summer impoundment. This represents a drop in lake level of 30 feet, and a decrease in lake area from 1,161 acres to 794 acres.

As formulated, low water release from the existing reservoir will maintain a summer flow in the Clarion River at Johnsonburg up to 220 cfs. It might be possible to increase this flow on weekends during the summer recreation season to accommodate recreational use of the river. A half-foot increase in stage of the Clarion River on week-ends could be attained by an increase of 200 cfs in outflow. Such a release over a 10 week period without runoff compensation would cause an additional seasonal drop in lake level of about 15 feet. However, flow augmentation

of this magnitude could probably be provided 9 years in 10 without endangering attainment of summer conservation storage level prior to the drawdown season.

At present East Branch Clarion water is somewhat degraded by acid mine drainage above the dam. The water is, however, of much better quality than the Mill Creek low flow which enters the Clarion River near the head of the scenic river reach. Consequently, dilution by East Branch water does enhance water in the valley and aid in the scenic development.

Elimination of mine pollution in the East Branch basin (now under active consideration for implementation) and resulting improved upstream quality would be advantageous to downstream water quality because of the proportionally higher contribution from the East Branch in the low water season, and the domination of its quality at that time.

Study of weekend augmentation to produce significant enhancement of the recreation potential on the river is justified. Fluctuations might be considered by local interests to hinder week long use along the stream. Effects on the overall pollution abatement program may result in fluctuating water quality (dilution) variations. A more uniform augmentation through the summer season, to increase flows by only 10 to 15%, would coincidentally improve river stages for water related recreation use, and provide additional water for treated waste assimilation.

East Branch Reservoir already has an operational schedule which provides annual drawdown closely related to available storage and runoff. Consequently, additional drawdown may present risk to its own optimum recreational and other development, without any appreciable benefit to downstream recreation, unless scenic river considerations would outweigh some lesser development. Local dissatisfaction may be expressed because of past drawdown experiences in East Branch lake levels.

Flood Frequencies

Since 1924, flows on the lower Clarion River at the St. Petersburg site have been influenced by storage and release of water through Piney Reservoir. Since December 1952, discharges have been further modified by operation of East Branch Clarion Reservoir. Records at the St. Petersburg site are only available between 1941 and 1953, prior to East Branch Clarion Reservoir. It is evident the development of natural damsite frequency of floods from modification of actual records would be extremely complex. Because of the method of operation and low release rates after flood impoundment at East Branch Reservoir, frequency for the uncontrolled area below East Branch Dam was believed suitable for analysis of the project area. Consequently, the frequency for the Clarion River at Cooksburg for the period from 1953 to date was computed

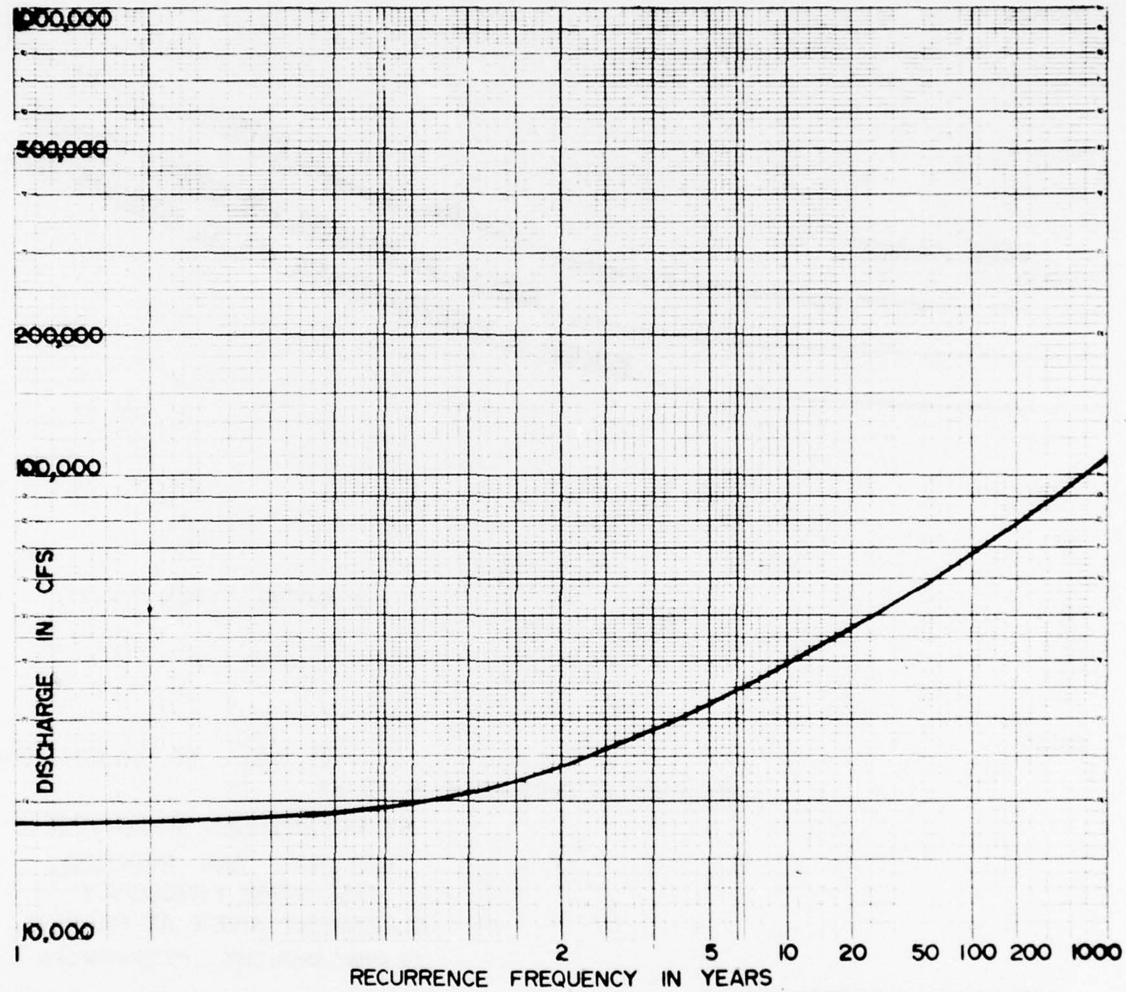
and a peak flow relationship developed between Cooksburg and St. Petersburg for the period of record, 1942 to 1953. These were correlated to obtain extended frequency data for the St. Petersburg site. All frequency analyses were prepared in accordance with ER 1110-2-1450 and OCE Civil Works Engineering Letter 63-5 with procedures set forth in the revised edition of "Statistical Methods in Hydrology", January 1962. Results of the frequency study are shown on Figure 11-14.

Frequency of natural flooding has been developed for the Allegheny River at Parker, a gaging station located 1.1 miles downstream from the mouth of the Clarion River, operated and maintained by the USGS. Records available for this station extend from water years 1885 through 1967, a span of 83 years. All floods from 1940 to date were adjusted for reductions by contemporary reservoirs. The computed reduction for all of the present reservoirs during the period of 1936 to date were used to develop a relationship between natural and modified peak flows. The natural frequency was converted to modified frequency by this relationship. A flood with an average recurrence interval of 1,000 years, reduced by the existing reservoirs, would reach elevation 872.1 at Parker. During high floods, there is approximately a three-foot fall in the water surface from the mouth of the Clarion River to the Parker gage. Accordingly, it is estimated that the elevation of a reduced 1,000-year flood at the mouth of the Clarion River would be 875. Since the stream bed elevation at the damsite is 879, the possibility of backwater flooding from the Allegheny River at the base of the dam is remote. Figure 11-15 shows natural and reduced frequencies for the Allegheny River at the Parker gage.

Similarly, flood frequency studies made at gage points at Kittanning and Natrona on the Allegheny River and Pittsburgh, Montgomery Dam, Pike Island and Dam 14 on the Ohio River, were used to evaluate flood stage reductions at these points by the formulated St. Petersburg site.

St. Petersburg Unit Hydrograph: Natural and Inflow

To develop unit hydrographs for the project site, the total drainage area was subdivided into its components areas. Hydrographs at the St. Petersburg gage at the damsite were not directly applicable. Development of the project site would result in inundation of the existing hydroelectric installation at Piney and necessitate its removal, thus altering the characteristics of flows at the damsite which have been influenced for about fifty years by Piney Dam storage and release operations. Unit graphs which have been developed for the basin are for theoretical six-hour periods of uniform rainfall. A unit graph has been computed for the Cooksburg gage. This latter graph was based on the flood of 16 October 1954, which was the result of a storm whose rainfall was fairly uniform over the upper Clarion Basin, and which was of fairly short duration. A reservoir inflow unit graph was obtained (1) from this unit graph by routing to the point on the river where the

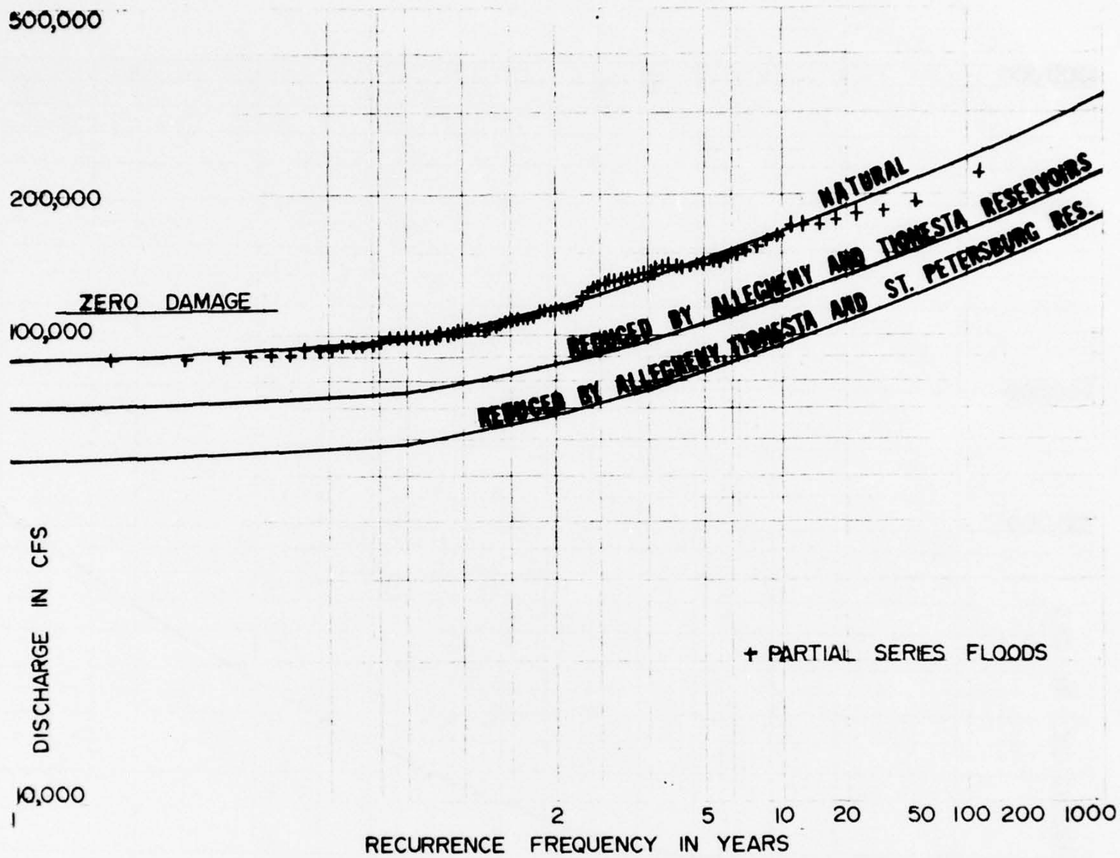


ST. PETERSBURG RESERVOIR
DISCHARGE FREQUENCY AT
DAMSITE REDUCED BY
EAST BRANCH RESERVOIR

U.S. ARMY ENGR. DIST PITTSBURGH, PA.

OCTOBER, 1967

FIGURE 11-14



ST. PETERSBURG RESERVOIR

NATURAL AND REDUCED DISCHARGE FREQUENCY

ALLEGHENY RIVER AT PARKER

U.S. ARMY ENGR. DIST. PITTSBURGH, PA.

FIGURE 11-15

elevation of the stream coincides with the proposed summer pool elevation 1,130; and (2) from an estimated unit graph for the intermediate local area between Cooksburg and the head of the project pool. The combined graphs represent a suitable unit graph for the total drainage area above the head of the reservoir pool.

Both natural and modified unit graphs were developed for the damsite. The procedure followed was to combine the unit graph for the area above the head of the pool with the unit graphs for each of the drainage subdivisions directly tributary to the reservoir. Theoretical unit hydrographs for the reservoir pool perimeter area were developed by dividing this area into eight stream drainage areas and five local overland areas. The unit graphs at the mouth of each of the eight streams were based on the unit graph control factors for Elk Creek at Ridgway and other nearby streams, with adjustments made for size and shape of drainage basin, length and slope of stream, and drainage configuration. Unit graphs for the five local areas were developed in a similar manner.

Both natural and inflow unit graphs were developed for the damsite. The natural graph was obtained by routing all of the individual graphs from their terminal points to the damsite, where they were combined. Routing coefficients of X of 0.4 and K of 0.0083 per mile of main stream traversed were used. The graph for the total area above the head of the pool was also routed to the damsite with the same coefficients and combined with the perimeter graphs to obtain the total natural unit graph, which is shown on Figure 11-16.

Development of the modified inflow unit graph proceeded in a somewhat similar manner. The unit graph was analyzed in three segments: major land flow from the river and the eight downstream tributaries above elevation 1,130, local perimeter land flow, and direct rainfall on the pool area. To obtain the major land flow, each of the eight downstream tributary graphs was modified to include only that portion draining into the stream upstream of elevation 1,130. These hydrographs were combined with the graphs for the Clarion River above the head of the pool. The local perimeter land area unit graph was developed by assuming that the peak flow would stabilize at the end of the six-hour runoff period at a flow equal to flow of full runoff concentration (1/6) inch per hour) with a total runoff duration of 9 hours. Direct rainfall on the pool area was represented by a six-hour uniform flow equivalent to 1/6 inch per hour over the area of the pool at elevation 1,130. These three graphs were combined to obtain the total modified unit graph, which is also shown on Figure 11-16.

Drought Periods

Previous to operation of East Branch Clarion River Reservoir Project starting in 1953, major deficiencies in flow on the Clarion River

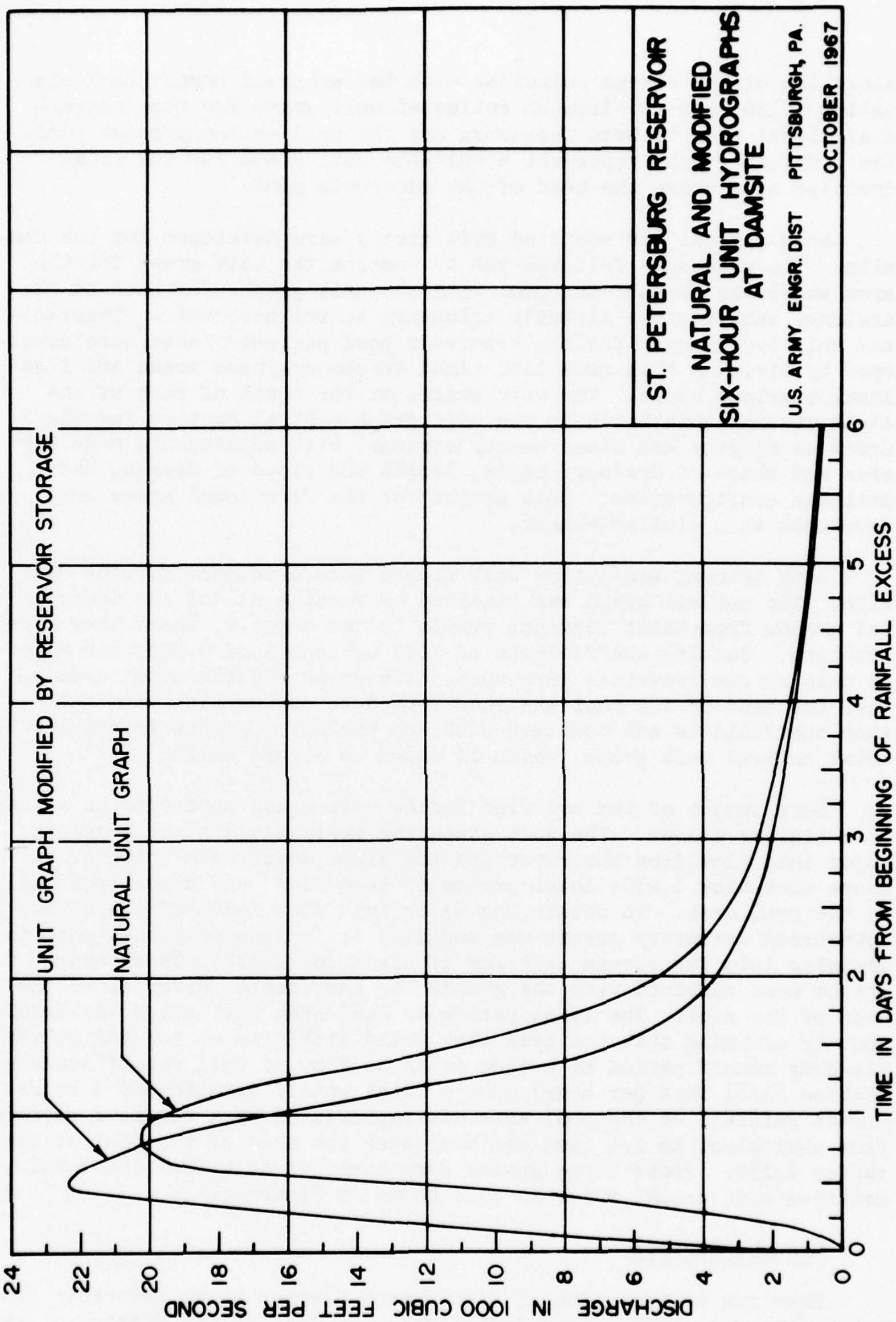

ST. PETERSBURG RESERVOIR
NATURAL AND MODIFIED
SIX-HOUR UNIT HYDROGRAPHS
AT DAMSITE
U.S. ARMY ENGR. DIST PITTSBURGH, PA.
OCTOBER 1967
UNIT GRAPH MODIFIED BY RESERVOIR STORAGE
NATURAL UNIT GRAPH
DISCHARGE IN 1000 CUBIC FEET PER SECOND
24
22
20
18
16
14
12
10
8
6
4
2
0
TIME IN DAYS FROM BEGINNING OF RAINFALL EXCESS
0
1
2
3
4
5
6

FIGURE 11-16

had been recorded. Presently, summer flows in the Clarion River as a result are maintained at a higher level than would prevail during a drought under natural streamflow conditions. Consequently, although an analysis of natural stream records of flow does not pertain directly to present augmented conditions, it does indicate flows that may be expected as local flow, or flow from the uncontrolled area. Evaluation of low-flow-duration-frequency for the Cooksburg record prior to regulation by East Branch Reservoir was related to the St. Petersburg site. Frequencies computed for varying durations of 1 day through 183 days are expressed in Table 11-14. For evaluation, the 183-day duration is an indication of a yearly dry season, because the average dry season lasts for half a year.

The drought period of 1930-1934 is the most severe of recent record. However, during water years 1931 and 1934, although only about one-half of normal runoff was recorded from the tributary area for each year, this exceeded by several inches the formulated summer conservation storage. This is significant because retention of summer recreation levels and flows in the scenic river reach below Ridgway are vital to recreation and other developmental aspects of the project.

Figure 11-9 illustrates the 1930-1934 drought period in relation to unconstrained drawdown for downstream low-water augmentation to meet the FWPCA water quality control schedule for the Ohio River at Pittsburgh (Sewickley gage). The basin runoff situation for such a recurrence would probably require reapportionment of flows from the entire reservoir system to meet the emergency.

TABLE 11-14
EXPECTED NATURAL LOW-FLOWS AT ST. PETERSBURG SITE

Occurrence Frequency in-Years	Duration of Period in Consecutive Days						
	1	7	14	30	60	120	183
	Average Discharge in cfs						
2	130	144	159	182	268	387	640
5	91	100	111	125	162	231	386
10	79	86	94	106	131	182	301
20	69	77	83	94	113	147	245
50	60	68	74	83	97	127	196
100	57	62	68	77	90	114	170

General Project Functions and Storage Allocations

The St. Petersburg site is formulated for multi-purpose functions. As a flood control reservoir, it would effectively supplement the existing Ohio River reservoir system, since it would increase control of the Allegheny River Basin by 10.6 percent. Its high degree of efficiency derives from the fact that the runoff from the Clarion River Basin is located near the mass-center of the presently uncontrolled part of the Allegheny River Basin which almost invariably coincides with the main volume of flood flow concentrating at Pittsburgh. As a result, reductions of up to three feet would be effected at Pittsburgh by holdouts during high floods. The potential project would also serve to augment low-flow for water quality improvement on the lower Allegheny and Ohio Rivers through seasonal release of 110,000 acre-feet of storage in conjunction with utilization of storage for the generation of pumped-storage and/or conventional hydroelectric power, thus compensating for elimination of the present power generation at Piney and serving a larger market. In addition to flood control, downstream low-flow augmentation, Clarion River Basin water quality control, and hydropower, the large reservoir water area would have the potential for development of water-based recreation. These qualities are developed below for the formulated project which would have the following pertinent features.

The reservoir would have a gross storage at maximum pool elevation 1,155 of 981,300 acre feet, representing 14.8 inches of runoff. The summer conservation pool would be elevation 1,130, providing 296,000 acre-feet or 4.46 inches of summer flood control reservation. The area at summer pool would be 10,140 acres, or 15.9 square miles. In an average year storage in the reservoir for water use withdrawal during the summer-fall recreation season would be generally limited to a maximum of 15 feet between elevations 1,130 and 1,115; providing 170,000 acre-feet for this purpose, of which 110,000 acre-feet are indicated for low-flow augmentation for water quality control. The minimum lake area for summer recreation with this drawdown would be 8,230 acres or 12.9 square miles. Winter drawdown level would be to elevation 1,111. Storage capacity between maximum and winter pool levels would be 465, 900 acre-feet or equivalent to 7.0 inches of runoff. A nominal permanent minimum pool would be at elevation 937, about 60 feet above the stream bed; representing 0.18 inch of storage. While it is not contemplated that operations would ever be implemented to drawdown to this low level, it is considered for structural design purposes. Loss of storage capacity due to sediment deposition during the life of the project would probably be insignificant based on sedimentation studies of other system reservoirs.

Area and Capacity Curves

The areas and capacities of the St. Petersburg site were obtained from U.S. Geological Survey topographic maps prepared in 1963 and later

having a scale of 1:24000 and 1:62,500 with contour intervals of 20 feet. The maps were planimetered by contour interval and the conic method for determining areas and capacities using a computer application was used in deriving the area and capacity curves shown on Figure 11-7.

Water Quality Control by Low-Flow Regulation

The low-flow augmentation that would be provided to the Ohio River by the reservoir would depend on the uncontrolled runoff and on the required FWPCA seasonal flow schedule at Pittsburgh (Sewickley gage). To meet the projected flow schedules stipulated by FWPCA for the year 2020, for extreme conditions such as occurred during the 1930 drought period, the maximum drawdown rate needed from the reservoir would be about 2,500 cfs. The average effect on water quality in the Clarion and Ohio Rivers from project outflow during the low-flow season is discussed later. The Corps of Engineers from its analysis of computer runs of reservoir operation concluded that an additional 110,000 acre-feet of storage would be required for release to the Ohio River to meet the expected deficiencies of the reservoir system for water quality remaining after increased degree of waste treatment and other control measures. The resultant flow schedules provided by FWPCA to be met by the system are expressed in Table 11-15 with unconstrained operational results shown on Figure 11-9, assuming no detriment to other purposes. Satisfaction of some portion of the needs in Table 11-15 from the St. Petersburg site contemplates needs remaining after Rowlesburg Lake becomes operational. Consequently, the solid-line on Figure 11-9 is an extreme situation. Unconstrained drawdown shown involves release of 459,000 acre-feet of storage during the last six months of 1930. All other low-flow requirements could be met within the allotted 110,000 acre-feet of storage. A detailed study based on varying release rates is not necessary at this time beyond computer runs for average daily release rates of 100 cfs, 1200 cfs, 1300 cfs, and 1600 cfs made for this study.

TABLE 11-15
FLOW SCHEDULE (IN CFS) REQUIRED FOR WATER QUALITY CONTROL AT PITTSBURGH

	YEAR OF REQUIREMENT		
	1980	2000	2020
January	3800	4400	5250
February	3950	4550	5440
March	4150	4800	5700
April	4550	5300	6250
May	4950	5750	6800
June	5500	6350	7500
July	5700	6600	7800
August	5600	6450	7650
September	5300	6150	7250
October	4700	5450	6450
November	4200	4850	5750
December	3950	4550	5400

Operational Procedure

An idealized reservoir operating rule curve is shown on Figure 11-8 consisting essentially of the following seasonal limiting pool elevations, pool areas and storage allocations assigned to all formulated project purposes.

Purpose	Elevation	Capacity Ac-Ft.	Pool Area Acres
Structural	937	--	--
Water Quality Control	1111-1130	110,000	--
Recreation	1111-1130	--	7780-10140
Flood Control	1111-1155	465,900	--
Hydropower*/	1111-1130	170,000	--

*/Interrelated with low-flow regulation for water quality control.

Overriding pool level requirements shown on Figure 11-8 would be as follows:

Reservoir Pool Level Elevation	Time
1111	18 December - 21 March
1111-1130	21 March - 1 May
1130	1 May - 31 October */
1130-1111	1 November - 18 December

*/ To optimize water quality control and power (critical period in October)

Flood Control Regulation Schedule

St. Petersburg Reservoir would provide 465,900 acre-feet of storage for flood control. Flood regulation effects are evaluated under that heading below. Procedurally at the onset of a major flood, St. Petersburg Reservoir would be operated to release 1,000 cfs whenever any of the following pre-flood discharges prevail:

Allegheny River at Lock 7, at or over 60,000 cfs;
Allegheny River at Lock 4, at or over 80,000 cfs;
Ohio River at Pittsburgh, at or over 110,000 cfs.

After the flood situation has crested and is receding at the downstream control points, post-flood regulations would become operable, providing these predicted discharge conditions prevail:

Lock 7, at or below 100,000 cfs within two hours;
Lock 4, at or below 130,000 cfs within four hours; and
Pittsburgh (crest reached or anticipated within two hours)
at or below 200,000 cfs within eight hours.

High and low-level gated outlet works in the dam structure would be needed for rapid emptying of the reservoir for flood control regulation. It is required that the gates would be operable to sensitively modify outflow by increments of 3,000 cfs, subject to the following reservoir and downstream limitations:

Peak outflow does not exceed peak inflow;
Outflow does not cause a recurring rising river; and
regulated flow at control points does not exceed 100,000 cfs at Lock 7, 130,000 cfs at Lock 4, or 170,000 cfs at Pittsburgh; and providing that the flood is not of the magnitude of a Standard Project Flood.

The amount of flood control storage is adequately provided at the capacity indicated, which is 7.0-inches in the winter and 4.5-inches in the summer seasons, to completely control all but the rare floods such as the Standard Project flood described below. For the latter, the high and low-level outlet works would permit regulation to cope with the rare conditions should they occur within the life-span of the project. Assumptions and computations regarding these floods and structural requirements for regulation relate to the height and length of the spillway and control gates, and the lower level, gated conduits.

The following derivations and discussions of Standard Project flood and Spillway Design flood are relevant to location, sizing and structural design of the gated spillway and outlet structures integral with the concrete dam dictated by site and foundation conditions.

Standard Project Flood

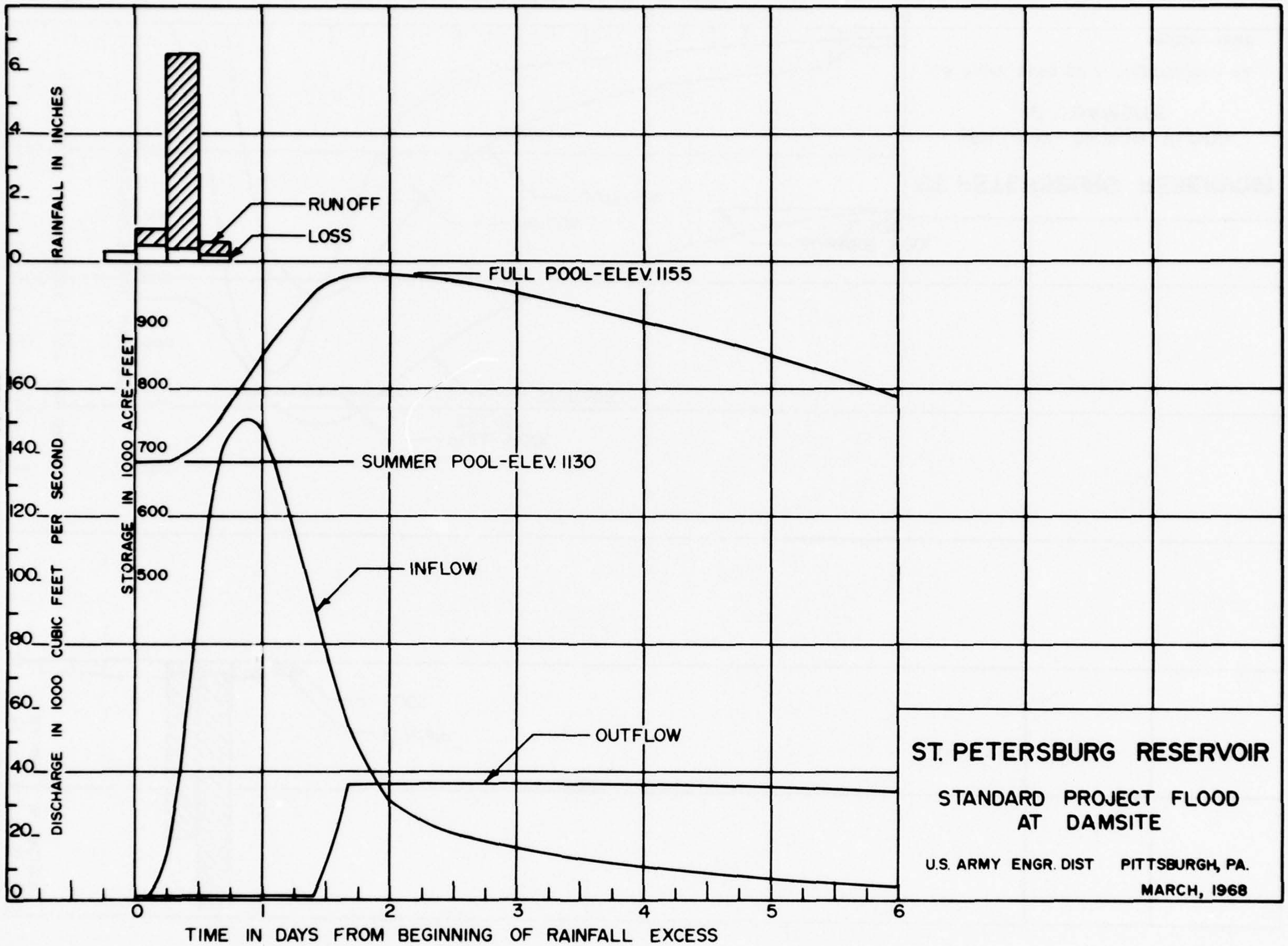
A standard project flood (SPF) developed for the St. Petersburg site recognizes the constraint established by the Commonwealth of Pennsylvania which restricts surcharge on the spillway to elevation 1,155 (1,160 at Cooksburg). This was used as the reservoir design flood. The flood was developed from rainfall of 10.9 inches over the basin for a four-day period (see Civil Engineering Bulletin No. 52-8, Office of the Chief of Engineers, dated 26 March 1952, subject "Standard Project Flood Determinations"). Rainfall infiltration losses of 3.6 inches, based on the July 1942 flood, were used with a resultant runoff of 7.3 inches. With initial

pool taken as elevation 1,130 (summer pool) a maximum storage elevation of 1,155 (full-pool) would be attained. The inflow profile at Cooksburg would not exceed the design constraint of elevation 1,160. The peak outflow would be 36,000 cfs. The peak reservoir inflow for the flood is 151,000 cfs and the peak natural flow 140,000 cfs. The routing of the SPF is shown on Figure 11-17.

Spillway Design Flood

Estimates of maximum rainfall used below in computing the spillway design flood for the St. Petersburg site were obtained from charts in Hydrometeorological Report No. 33 by the U. S. Weather Bureau, dated April 1956. A Type IV storm, a decadent tropical storm which tends to occur in late summer or early autumn, produced the most critical storage condition. Consideration was given to instructions from the Office of the Chief of Engineers concerning the Hop Brook Reservoir in Connecticut, in which it was deemed reasonable to apply empirical corrections to the rainfall of the Type IV storm. Infiltration losses were based on those observed during the October 1954 flood in this region. The total rainfall for Type IV (in September) storm over the Clarion River Basin is 16.0 inches. Infiltration losses amount to 2.8 inches, with resultant runoff of 13.2 inches.

A modified inflow unit hydrograph was applied to the rainfall-excess of the adopted spillway design storm to determine the design flood hydrograph. The base flow was assumed to be 100 cfs., based on the mean minimum flow for September at St. Petersburg. At storm inception, storage was assumed to be halfway between summer pool elevation 1,130 and full pool elevation 1,155, since it is conceivable that another storm of relatively high intensity could occur prior to the spillway design storm. For purposes of routing the spillway design flood, various combinations of spillway length and gate size were tried from which it was assumed that the spillway would be most effectively controlled by seven gates, each 27 feet high and 45 feet wide. The maximum pool elevation attained as a result of the spillway design flood would reach 1158.5, or 3.5 feet above the full pool elevation of 1,155. With these conditions, the peak reservoir inflow and outflow are 273,000 and 215,000 cfs., respectively. The natural spillway design flow at the damsite was computed to be 257,000 cfs. The precipitous valley below the dam to the mouth of the river would offer little restraint on rate of outflow. Other purpose conditions would govern. However, the range of combinations is not too sensitive, and the discharge gates are of optimum size to permit rapid evacuation of flood storage equivalent to 5 inches of runoff within 10 days for most effective operation. The results of the reservoir regulation during passage of the spillway design flood are shown on Figure 11-18. Structural and geologic investigations later in this report section relate to these hydrologic and hydraulic criteria for most economy in design for construction and operation.

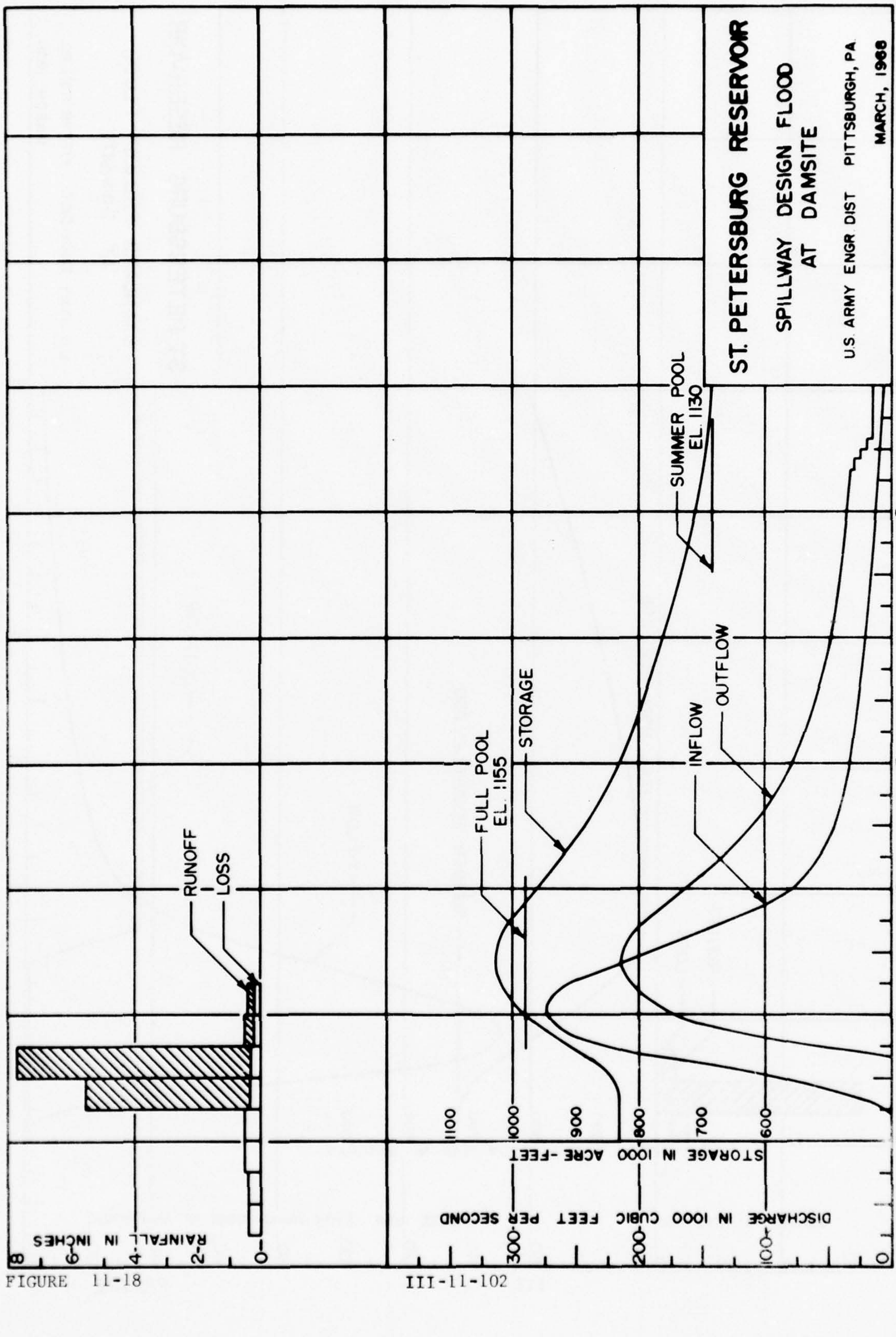


ST. PETERSBURG RESERVOIR

STANDARD PROJECT FLOOD
AT DAMSITE

U.S. ARMY ENGR. DIST PITTSBURGH, PA.
MARCH, 1968

FIGURE 11-17



ST. PETERSBURG RESERVOIR
SPILLWAY DESIGN FLOOD
AT DAMSITE
U.S. ARMY ENGR DIST PITTSBURGH, PA
MARCH, 1968
RAINFALL IN INCHES
RUNOFF
LOSS
STORAGE IN 1000 ACRE-FEET
DISCHARGE IN 1000 CUBIC FEET PER SECOND
FULL POOL
EL. 1155
STORAGE
INFLOW
OUTFLOW
SUMMER POOL
EL. 1130
TIME IN DAYS FROM BEGINNING OF RAINFALL EXCESS
0
1
2
3
4
5
6
0
2
4
6
8
1100
1000
900
800
700
600
0
100
200
300

FIGURE 11-18

Recommended Spillway

The most effective spillway length has been limited to the spillway potential to provide design flood outflows not in excess of the natural peak flows with a maximum of 5 feet of controlled surcharge storage. The length of the spillway would also approximate the natural channel width to permit a smooth transition of flow from spillway to channel. To effect this flexibly the 7 gated bays above, each 45 feet wide, were selected. With a summer conservation at pool elevation 1,130.0 contemplated for about six months of the year, a spillway crest elevation of 1,130.0 was selected to assure testing and maintenance of the crest gates, without unduly lowering the recreation pool. Therefore, for design criteria, the overflow capacity is considered to be to the extent that the conduits, opened simultaneously with spillway overflow to gain the total outflow required to control extremely large floods, will limit the pool to elevation 1,158.5. This is within the elevation 1,160 constraint. The total outflow capacity is shown on Figure 11-19.

Recommended Outlet Works

Seven gated conduits are recommended for the dam structure, as indicated, with 6 designed for release of flood impoundment at elevation 890.0. The seventh conduit, at elevation 924.0, is designed for temperature control to release warmer, stratified water expected in the impoundment. Only in the case of an emergency would this conduit be used to release flood waters. The 6 lower level conduits are designed herein to accommodate release of spillway and conduit flows simultaneously due to the spillway limitations imposed by the elevation 1,160 constraint. Bankfull flow of 35,000 cfs is also a controlling factor in assessing the number, level, and size of the lower conduits, with the natural stream width being the other consideration as indicated above. The conduit rating is shown on Figure 11-19.

Reservoir Regulation - St. Petersburg as a Unit in Allegheny and Ohio River System

St. Petersburg would be operated in its best position in conjunction with the Allegheny River System and the Ohio River System with appropriate transfers and tradeoffs when feasible without violating the formulated project purposes. Flood control, and water quality and power releases from St. Petersburg would be coordinated with those reservoirs performing similar functions in the Allegheny River and overall system above Pittsburgh. Flood regulation effects of St. Petersburg, discussed below, would be significant in comparison with the capabilities of the total system. Recreation potentials of the Allegheny River Reservoir, East Branch Clarion Reservoir, and the St. Petersburg site development, in view of their respective water quality and water

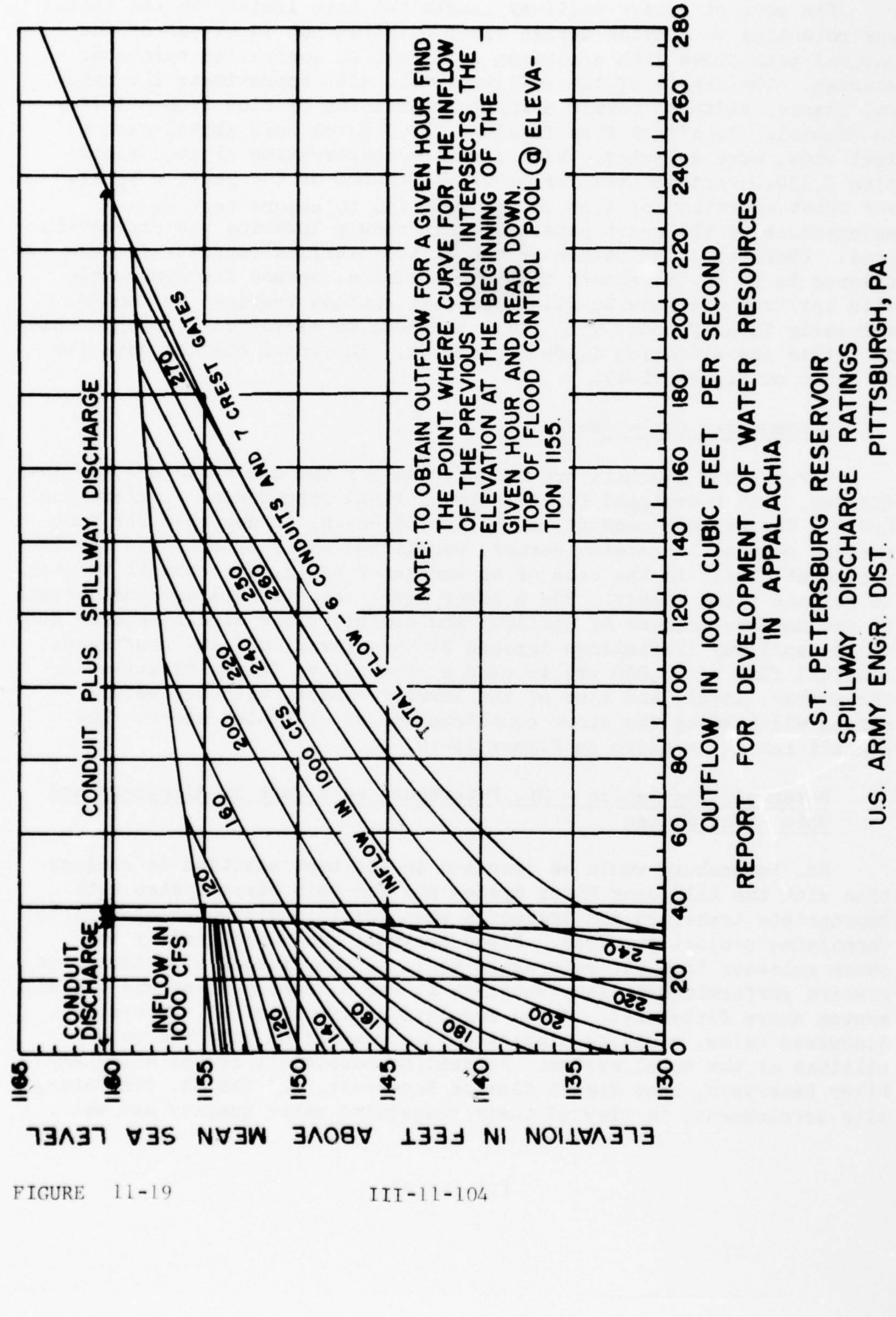

CONDUIT PLUS SPILLWAY DISCHARGE
CONDUIT DISCHARGE
INFLOW IN 1000 CFS
INFLOW IN 1000 CFS
TOTAL FLOW - 6 CONDUITS AND 7 CREST GATES
NOTE: TO OBTAIN OUTFLOW FOR A GIVEN HOUR FIND THE POINT WHERE CURVE FOR THE INFLOW OF THE PREVIOUS HOUR INTERSECTS THE ELEVATION AT THE BEGINNING OF THE GIVEN HOUR AND READ DOWN.
TOP OF FLOOD CONTROL POOL @ ELEVATION 1155.
OUTFLOW IN 1000 CUBIC FEET PER SECOND
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
REPORT FOR DEVELOPMENT OF WATER RESOURCES IN APPALACHIA
ST. PETERSBURG RESERVOIR
SPILLWAY DISCHARGE RATINGS
U.S. ARMY ENGR. DIST. PITTSBURGH, PA.

FIGURE 11-19

supply capabilities, offer rather important elements which would merit detailed systems analysis for proper coordination. Water supply for the off-river community of Butler, Pennsylvania, which is derived from the Allegheny River below the mouth of the Clarion River, and for Clarion, Pennsylvania, and vicinity, may offer a systems-coordinated possiblity without any significant drawdown result. Canoeing of a type attractive to those not seeking white water conditions would have a probability of development between the scenic river between Cooksburg and Ridgway by weekend releases from East Branch Clarion Reservoir. Depending upon releases from the reservoirs in the Allegheny River system some more beneficial recreation use could possibly be made of the reregulating reservoir on the Clarion River below the St. Petersburg damsite discussed below in relation to the hydroelectric power potential. Also, the contribution of this project to water quality control would permit more uniform releases from Allegheny River Reservoir to aid in stabilizing water levels in the upper Allegheny River. Pertinent data on the St. Petersburg Project are shown in Table 11-16.

Control Points

The control points for flood operations would be those used presently, namely the upper gages at Locks 7 and 4, Allegheny River, and the Pittsburgh gage, Ohio River. For water supply and water quality, control points would be Lock 4, Allegheny River and Sewickley, Ohio River.

Reservoir Regulation Effects

Operated for flood control regulation as specified above, St. Petersburg Reservoir would effectively modify downstream flood flows in the Allegheny and Ohio Rivers to give additional protection to existing developments and encourage new ones by flood-freeing needed lands, to lower flood peak heights; would furnish low-flow augmentation downstream for water quality control during times of flow deficiencies, and water supply for communities which draw water from the Allegheny River; would aid in stabilizing flow levels in the upper Allegheny River by coordinated regulation and in abating acid drainage emergencies in the lower Allegheny River; and would yield an opportunity to develop hydroelectric power generation.

Flood Control

St. Petersburg Reservoir would store a significant volume of flood waters, which arrive at the control points above coincidentally with other peak concentrations, and would be able to later release these holdouts so that no augmentation of peaking flood crests would result. An exception to this would, of course, be in the case of the occurrence of an exceedingly large, rare flood of the character of the standard project flood, which would be reduced an effective amount.

TABLE 11-16
PERTINENT DATA - ST. PETERSBURG PROJECT

Project purposes:	Flood control; hydro-electric power generation; water supply; water quality control; recreation; and economic development.
Location of dam, miles above mouth	5.0
Drainage area, sq. mil.	1,245
Type of dam	Concrete
Outlet Works High Level	Gated, 7 gates, 45 ft. wide and 27 ft. high, ogee weir with crest elevation 1130, top of gates elevation 1157, design discharge capacity 215,000 cfs.
Low Level	7 sluices, 6 at elevation 890 (5'-9" x 10'-0"), 1 at elevation 924 (5'-8" x 10'-0")
Elevations, ft. msl	
Top of dam	1167.5
Spillway design flood	1158.5*/
Standard project flood	1155
Top of spillway gates	1157
Full flood control pool	1155
Regulated summer pool	1130
Regulated winter pool	1111
Crest of spillway	1130
Permanent pool	937
Stream bed	879
Reservoir area, acres	
Reservoir full	13,590
Summer pool, maximum	10,140
Summer pool, minimum	8,230
Winter pool, minimum	7,780
Permanent pool	-
Storage, acre feet (watershed inches)	
Gross	981,300 (14.78)
Flood control, summer, minimum	295,900 (4.46)
Flood control, summer maximum	433,900 (6.56)
Flood control, winter	465,900 (7.02)
Water supply	**/
Water quality control	110,000 (1.66)
Supplemental storage	563,128 (8.48)
Permanent pool	12,000 (0.18)

*/ Elevation 1160 constraint at Cooksburg.
**/ To be determined.

For example, the average stage reductions, resulting from operation of the St. Petersburg Project, during the 100-year flood, would be as follows at the various damage points: Parker, Allegheny River, 4.0 feet; Kittanning, Allegheny River, 2.8 feet; Natrona, Allegheny River, 3.1 feet; Pittsburgh, Ohio River, 2.7 feet; Montgomery Dam, Ohio River, 2.7 feet; New Cumberland, Ohio River, 2.7 feet; Pike Island Dam, Ohio River, 2.8 feet; and Dam 14, Ohio River, 2.8 feet. A more complete stage reduction resume is shown on Figures 11-20 through 11-22.

Water Quality Control and Water Supply

Low-flow augmentations by St. Petersburg Reservoir regulation would supplement the existing reservoir system capacity allocated to water quality control. Management of the 110,000 acre-foot storage allocation in the space between elevations 1115-1130, designed to be of good quality, would provide increased flows to maintain water of requisite quality at downstream points (with estimated waste loads and time-phased degree of waste water treatment) as projected to year 2020, particularly on the Ohio River at Pittsburgh (Sewickley gage). Assuming that hydroelectric power generation facilities and generation would materialize, the project would provide additional increased flows daily to the system to satisfy downstream requirements. This would reinforce the downstream situation, particularly if projected waste loads would be exceeded or degree of waste water treatment would not be in synchronization with the projected loads. Based on preliminary evaluations by the Commonwealth of Pennsylvania at a water temperature of 25°C (77°F), each cfs of flow augmentation of increased flow released will provide 45 pounds per day of dissolved oxygen in the Pennsylvania reach of the Ohio River to help maintain water quality at or above water quality standards. The regulation procedures would be monitored to accomplish this objective. St. Petersburg Reservoir regulation pertinent to water quality downstream would be designed also to reflect dissolved solids standards downstream which are not to exceed 500 mg/liter as an average, or 750 mg/liter at any time. In the systems approach, increased municipal and industrial growth and increased water quality standards relating to systems abatement efforts will increase the dissolved solids concentrations in the Ohio River, especially if acid neutralization generally is accomplished in part by treatment plants employing lime or other alkaline substances. St. Petersburg regulations relevant to the Ohio River would in turn be relevant to practices in the Clarion River relating to sewage and industrial wastes and acid abatement measures in the Clarion River Basin. Measures which are prerequisite to the project, those which would be supplemental and continued by the Commonwealth would be based upon water quality standards adopted for this basin. From Johnsonburg to the mouth of the Clarion River, it is anticipated that secondary treatment of waste discharges will be adequate for municipal discharges and in the absence of the St. Petersburg Reservoir. Expansion of the papermill at Johnsonburg will require either tertiary treatment or additional in-plant controls. Installation of a large multiple-purpose reservoir on the Clarion River at St. Petersburg will require tertiary treatment of municipal and industrial discharges for phosphorus removal (above 80% to 90% removal) in order to prevent eutrophication of the reservoir. This treatment would be required for all wastes flowing into the reservoir. Consequently, St. Petersburg Reservoir regulation based

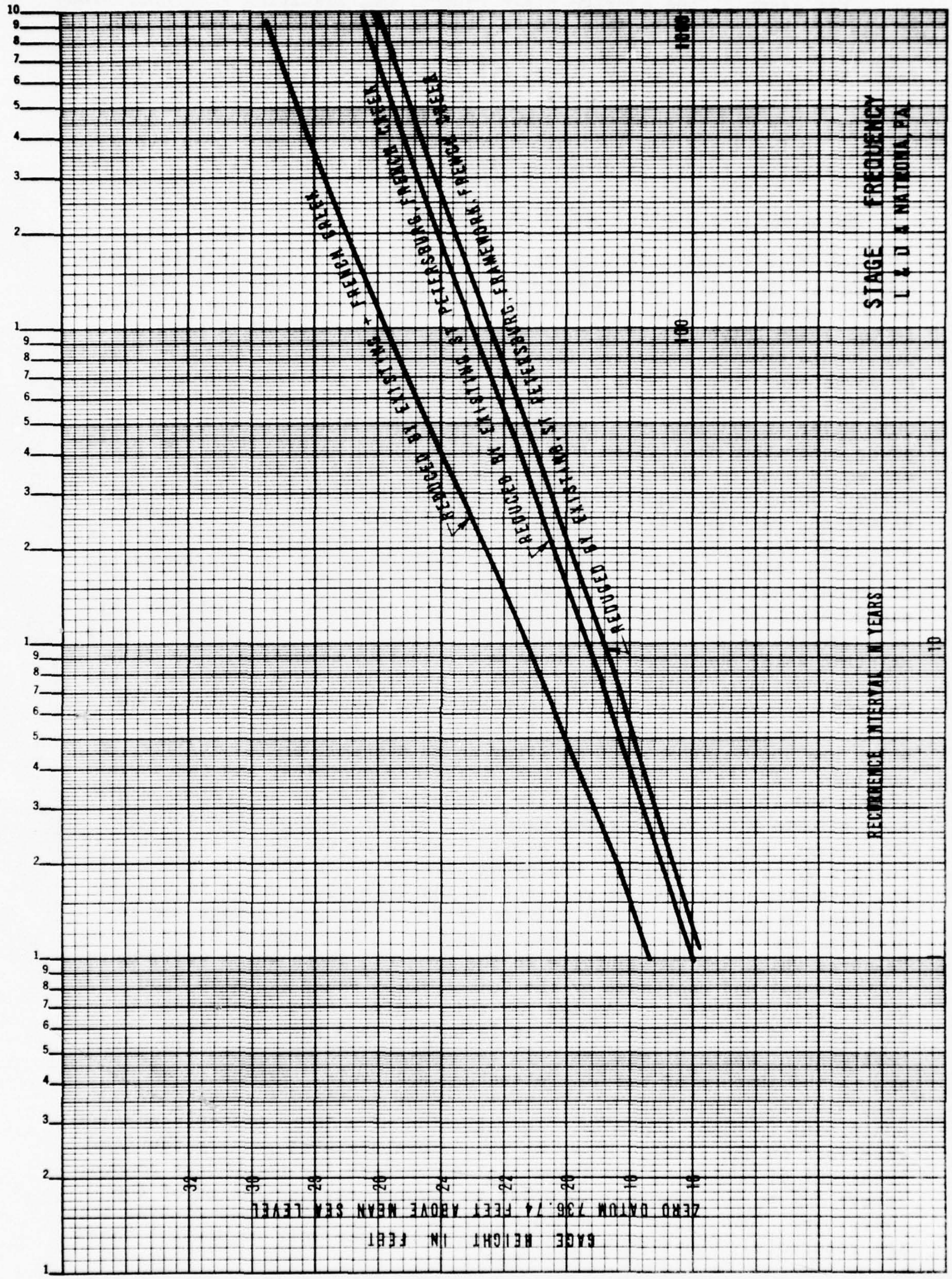

STAGE FREQUENCY
L & D 4 NATRONA, PA.
RECURRENCE INTERVAL IN YEARS
GAGE HEIGHT IN FEET
ZERO DATUM 736.74 FEET ABOVE MEAN SEA LEVEL
REDUCED BY EXISTING + FRENCH CREEK

FIGURE 11-20

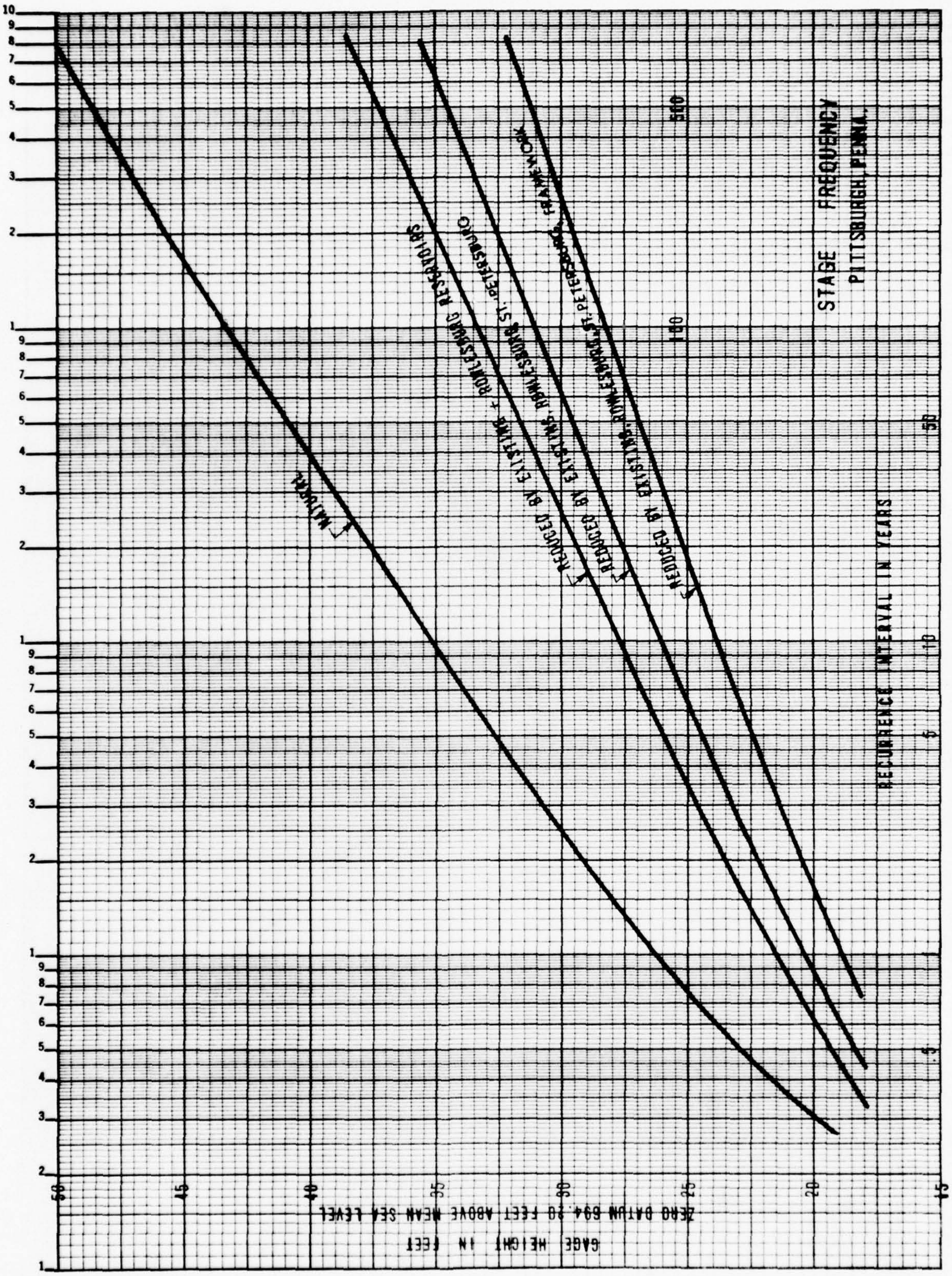

STAGE FREQUENCY
PITTSBURGH, PENNA.
NATURAL
REDUCED BY EXISTING + ROWLESBURG RESERVOIRS
REDUCED BY EXISTING, ROWLESBURG, ST. PETERSBURG
REDUCED BY EXISTING, ROWLESBURG, ST. PETERSBURG, FRAMEWORK
RECURRENCE INTERVAL IN YEARS
GAGE HEIGHT IN FEET
ZERO DATUM 694.20 FEET ABOVE MEAN SEA LEVEL

FIGURE II-21

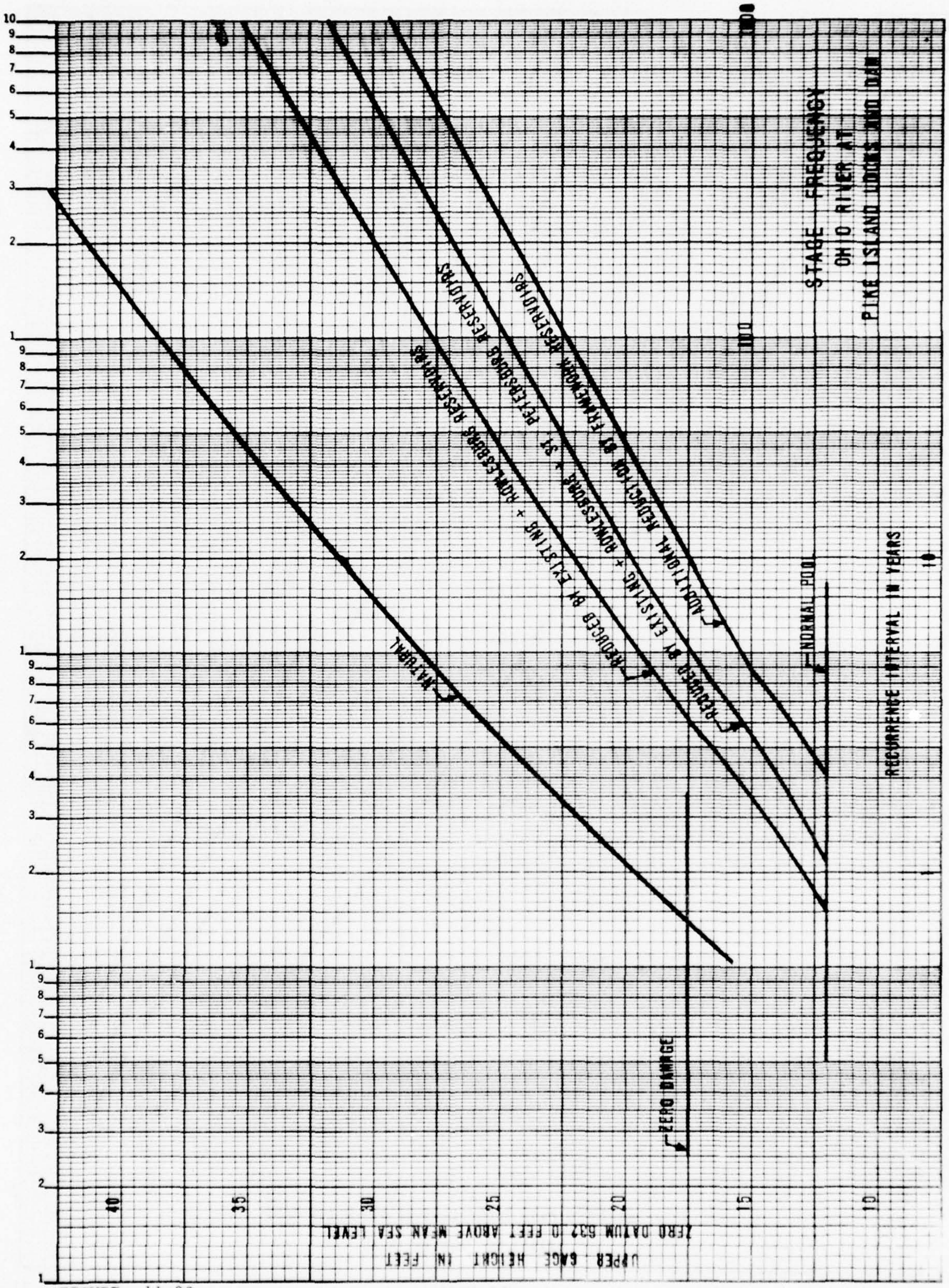

STAGE FREQUENCY
OHIO RIVER AT
PIKE ISLAND LOCKS AND DAM
RECURRENCE INTERVAL IN YEARS
UPPER GAGE HEIGHT IN FEET
ZERO DATUM 632.0 FEET ABOVE MEAN SEA LEVEL
NATURAL
REDUCED BY EXISTING + BOWLESBURG RESERVOIRS
REDUCED BY EXISTING + BOWLESBURG + PETERSBURG RESERVOIRS
ADDITIONAL REDUCTION BY FRAMEWORK RESERVOIRS
NORMAL POOL
ZERO DAMAGE
40
35
30
25
20
15
10

FIGURE 11-22

on selected, mixed outflow would fulfill downstream quantitative requirements and at the same time meet Commonwealth water quality standards to a great extent.

Combined Regulation for Hydroelectric Power, and Water Quality Control

St. Petersburg Reservoir would provide storage for hydroelectric power, water quality control, and replacement and future water supply and by a facile combination of regulation and reservoir level criteria and facilities would provide most favorable recreation levels throughout the year. By these, regulation for multiple-purposes would realize to the project the advantageous recreation level range, and would meet Ohio River low-flow augmentation requirements and hydropower generation. This assumes that power facilities would be installed initially or later as Federal or private development. Sufficient runoff during months of March, April and May, to impound 7-inches or more, would coincidentally assure low-flow and power use to meet full project objectives, especially with the added flexibility of recirculation between an optimally sized upper pumped-storage reservoir and the main reservoir should inflow be lower at any time than anticipated, particularly in a drought period. The preceeding discussion of drawdown conditions reflects the reservoir regulation effects over time and under the extreme range and size of multiple-purpose functions needed.

Hydrologic Network

The existing precipitation and stream gaging stations, shown on Figure 11-13, (Page III-11-83) form a basis from which to organize a network of reporting stations to be used in conjunction with the operation of the St. Petersburg Reservoir Project. In addition, the reactivated stream gaging stations on the Clarion River at St. Petersburg would be used as an outflow station. A precipitation gage would also be installed at the damsite. Readings from the stations presently in the East Branch Reservoir network would continue, and additional readings would be made at the project site. Water quality monitors and stations to furnish needed biological and operational information will be sited, installed, and operated cooperatively with Interior, Agriculture, state and local interests and others such as USGS, USWB, as appropriate.

12. GEOLOGIC

Geologic Area

Geologically, the St. Petersburg project area near the mouth of the Clarion River, is in the unglaciated Allegheny Plateau.

The damsite location is at approximate elevation 879. The river follows a meandering course, being entrenched more than 500 feet below the general level of the ridge crests.

The valley pertinent to the dam and impoundment sites, particularly from lower levels up to its plateaus, is narrow and steep-sided. Flood plains in this region are virtually absent and there are no developed alluvial terraces. Valley walls are covered with thin stoney, sandy soils. Valley bottoms have a thin covering of gravelly and cobbley material in the river bed, lacking development of any appreciable amount of fine grain soils.

Basin Geology

Rocks of the overall Clarion River belong to the Allegheny, Pottsville and Pocono groups of the Pennsylvanian and Mississippian age. The rocks are flat-lying, chiefly sandstone, sandy shales and some shales with coal seams that are economically minable. The Vanport limestone is mined in the western part of the basin on a commercial basis. High level granular deposits cover high terraces adjacent to the Allegheny River. Bedrock is exposed through thin soil on most valley walls and in the streambed itself with the stream flowing on bedrock within poorly developed flood plains. Generally, the area is highly dissected with little flat land and well developed dendritic drainage pattern. Total relief within the basin approaches 1,000 feet. Oil and gas have been exploited over the last 70 years with most fields having low yields and probably nearing depletion without revised recovery methods.

Design Geology

Geology for the St. Petersburg site involved analyses for the damsite and the impoundment site areas relative to structural foundation capability, imperviousness, availability of construction materials, and mineral dislocations.

General Site Geology

A geologic section along the axis of the dam is shown on Figure 11-23 and log of core borings on Figure 11-23a. A concrete dam would be founded on a hard sandstone and well cemented shales for the entire section. The general bedrock structure of the area is not a pronounced syncline or anticline but a generally rising surface to

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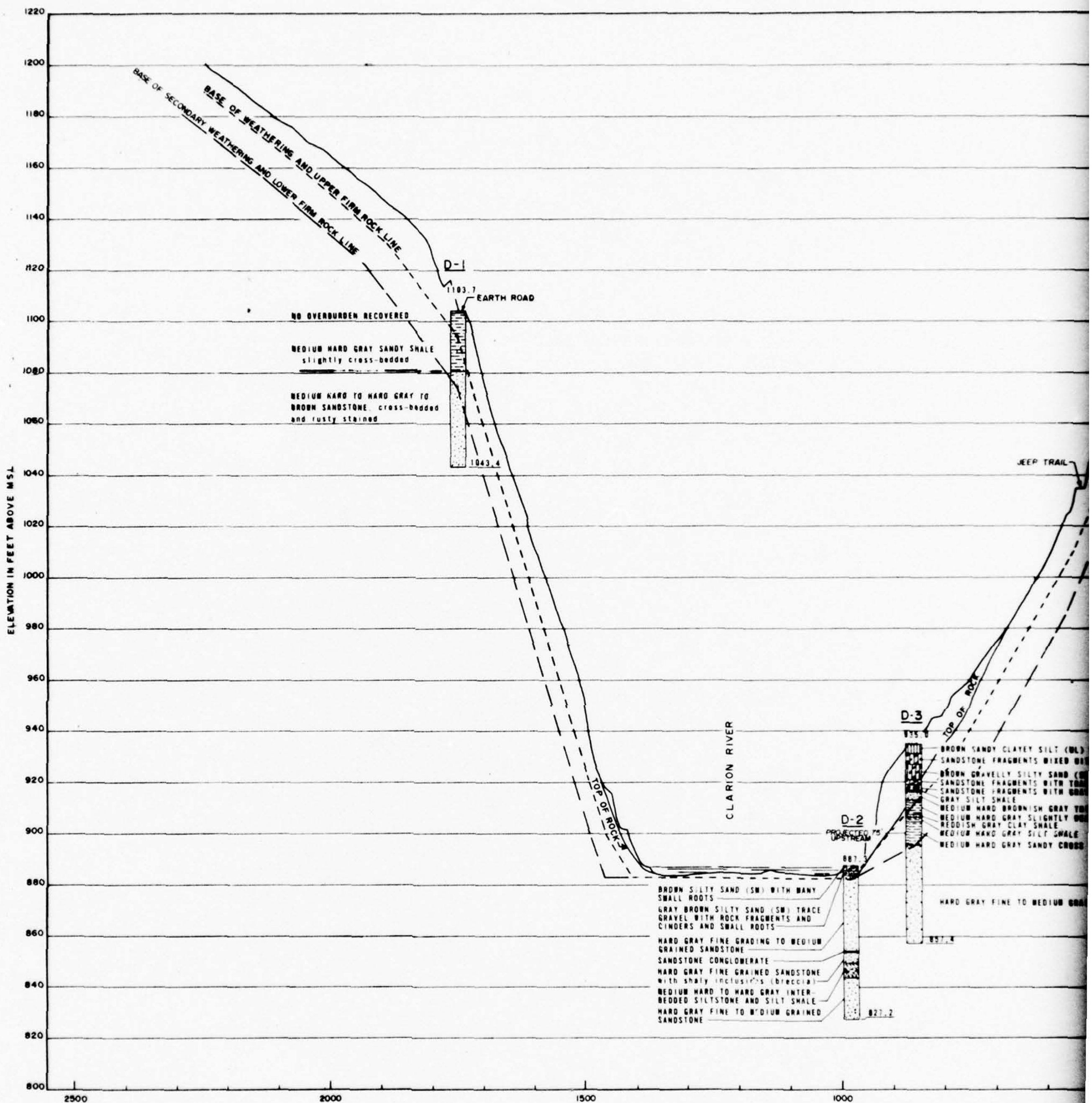
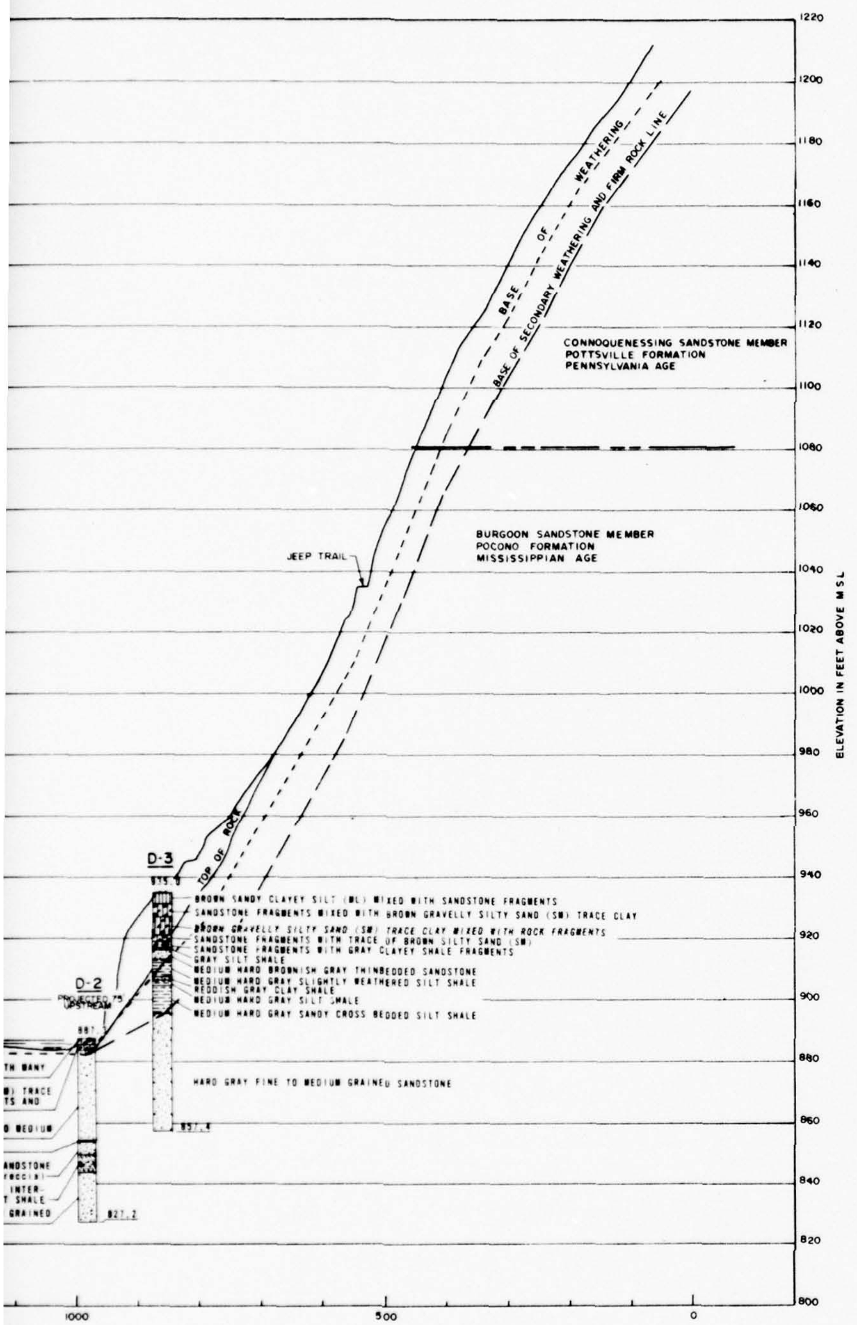
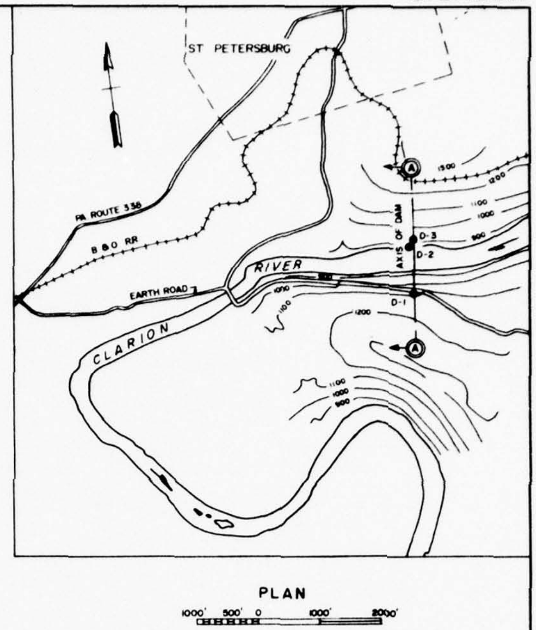


SECTION A - A

SECTION TAKEN LOOKING DOWNSTREAM
DAM STATIONING

U. S. ARMY





PLAN

REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE

U. S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

PREPARED BY: F. PEHR
DRAWN BY: F. TOMASIC
CHECKED BY:
SUBMITTED BY:
CHIEF FOUNDS. AND MATERLS. BR.
APPROVAL RECOMMENDED:
CHIEF ENGINEERING DIVISION
APPROVED FOR:
DATE:

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
CLARION RIVER, PENNSYLVANIA
ST. PETERSBURG RESERVOIR
FOUNDATION EXPLORATION
PLAN AND SECTION A - A

APPROVED: DATE:
COLONEL, CORPS OF ENGINEERS DISTRICT ENGINEER
SCALE: AS SHOWN SPEC. NO.:
DRAWING NUMBER
SHEET 1 OF 1

FIGURE II-23

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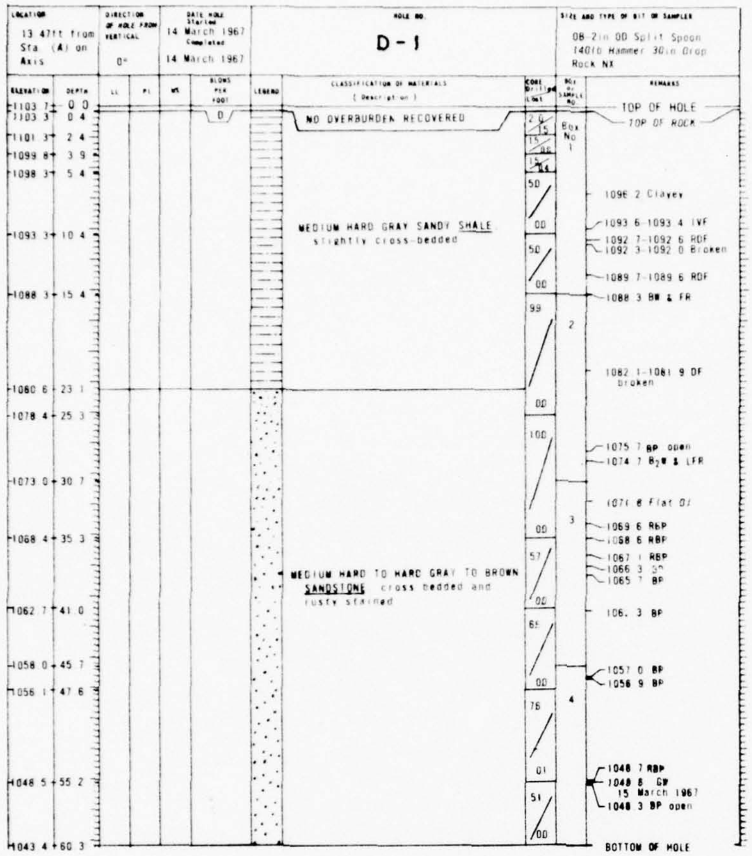
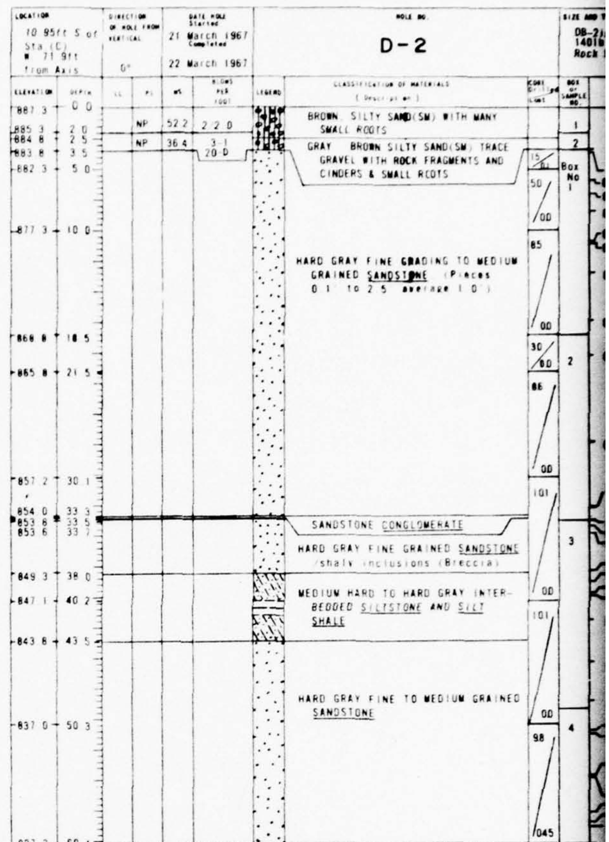
CORPS OF ENGINEERS





ABBREVIATIONS

/	With
BW	Base of Weathering
B_2W	Base of Secondary Weathering
BP	Bedding Plane
DF	Diagonal Fracture
FR	Firm Rock
GW	Ground Water
VF	Vertical Fracture
IVF	Irregular Vertical Fracture
RBP	Rusty Bedding Plane
RDF	Rusty Diagonal Fracture

GENERAL NOTES

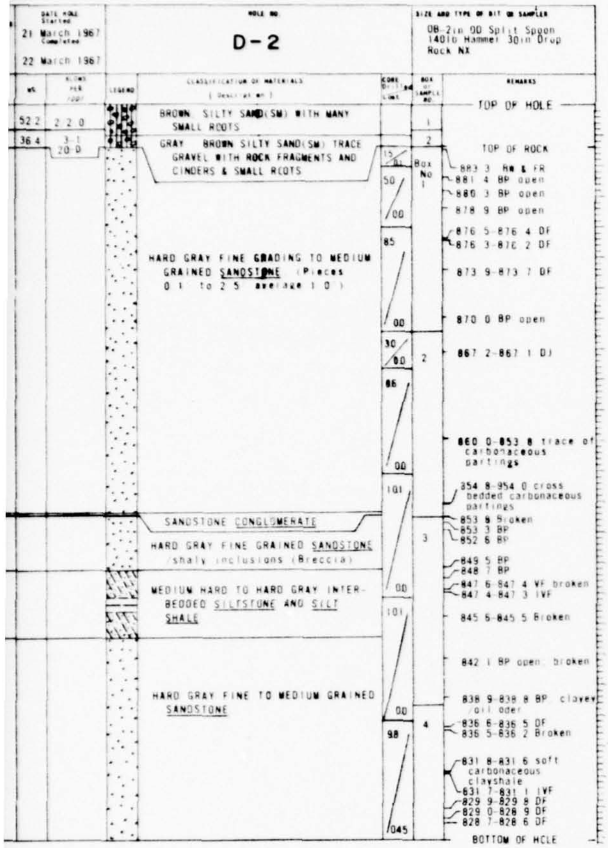
Rock cores and jar samples of the over[...] testing are available for inspection dur[...] Pittsburgh Engineer Warehouse and Repair [...] 15225 The overburden samples have dried [...] moisture contents do not correspond to th[...]

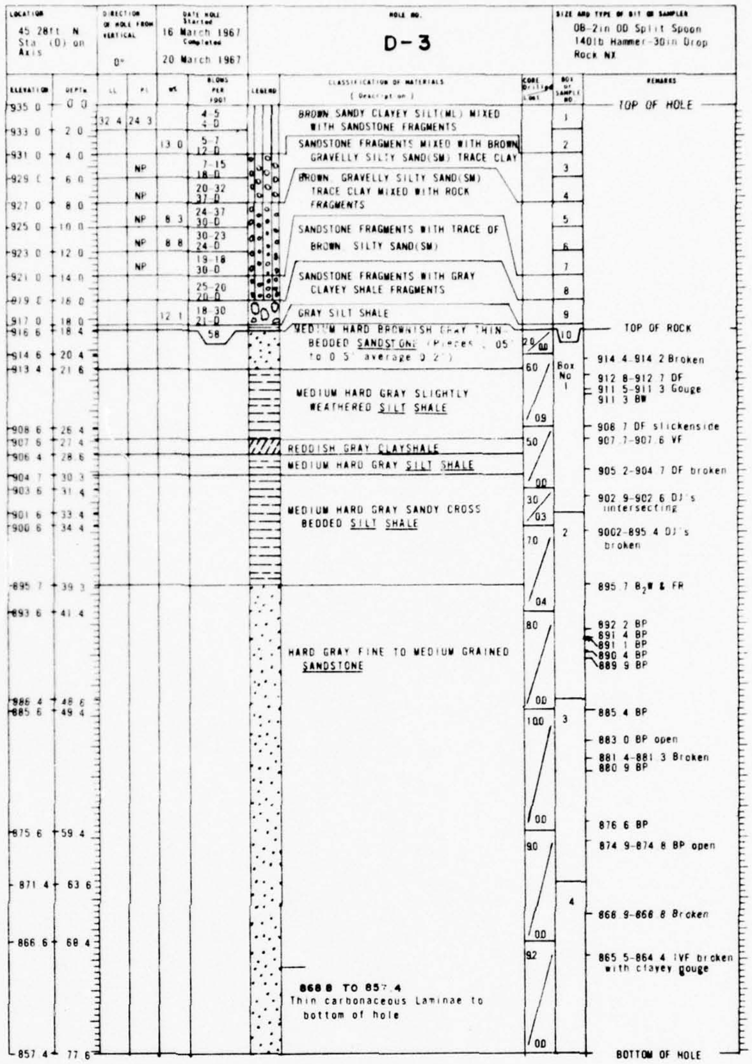
Classification (cross-hatched symbols) [...] materials are shown in accordance with th[...] Plate No 1 of the U S Army Corps of Eng[...] dated 9 November 1959 shown on reference [...]

The blows per foot column reads as fo[...]

1st 6 inches — 2-3 — 2nd 6 inch[...]

3rd 6 inches — 5-D — Drilling o[...] cleanout





GENERAL NOTES

Rock cores and jar samples of the overburden, except those destroyed by testing, are available for inspection during the bidding period at the Pittsburgh Engineer Warehouse and Repair Shop, Neville Island, Pennsylvania 15225. The overburden samples have dried during storage and their present moisture contents do not correspond to the moisture content when drilled.

Classification (cross-hatched symbols) and group symbols for the overburden materials are shown in accordance with the United Soil Classification System Plate No. 1 of the U.S. Army Corps of Engineers, Engineering Manual EM-1110-1-1806 dated 9 November 1959, shown on reference drawings D-224-1.

The blows per foot column reads as foolows

1st 6 inches — 2nd 6 inches
2-3
5-0
3rd 6 inches — Drilling or cleanout

REVISION	DATE	DESCRIPTION	BY

GRAPHIC SCALE

U. S. ARMY ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
PITTSBURGH, PENNSYLVANIA

PREPARED BY: F. DEGROSKY
DRAWN BY: WEG / D.W.
CHECKED BY:
SUBMITTED BY: CHIEF, FOUNDATIONS AND MATERIALS BR
APPROVAL RECOMMENDED: J.E. Mcinnotts, CHIEF ENGINEERING DIVISION
APPROVED: COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER
APPROVED FOR:
DATE:

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
CLARION RIVER, PENNSYLVANIA
ST PETERSBURG RESERVOIR
FOUNDATION EXPLORATION
BORINGS
HOLES D-1 TO D-3 INCLUSIVE

DATE: 15 MAY 1967
SCALE: AS SHOWN
SPEC. NO.:
DRAWING NUMBER 038b-R13-10/2
SHEET 1 OF 1

FIGURE - 23a

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the north with minor undulations. The key beds rise to the north approximately 5 feet per mile. The bedrock across the dam axis is essentially flat lying. The generalized columnar section on Figure 11-24 shows the formations in which the dam would be located. Bedrock is exposed on the valley walls. The exposed rock is chiefly cross-bedded sandstone with bedding an inch or so thick with some beds in massive layers more than two feet thick. Well jointed sandy shale out-crops near the streambed. Further up the slope, near elevation 1040, dark gray silty to sandy shale, about 30 feet thick, is found on both sides of the valley. No soft shales or indurated clays were found in the section. The left valley wall drops in a series of short cliffs which were probably formed by vertical joints striking north 85 east subparallel to the river. Some cross joints north 35 to 45 east were found in outcrops at higher elevations. Bedrock is also visible in the bed of the Clarion river. Boulders and cobbles and large blocks of sandstone cover the valley bottom. The thickness of this deposit is estimated to be less than 5 feet. It is believed that the massive sandstone of this section has prevented the adjusting of the thalweg to the gradient of the Allegheny River which is approximately 5 miles downstream. Thick deposits of colluvial and alluvial soils are not present in the valley bottom. There are, however, remnants of the Carmichaels Formation, a high terrace deposit in the area. These deposits cover the flat areas of the damsite. These deposits are reported to be chiefly sand, silt and clay and deeply decayed water-worn pebbles of local derivation. The thickness of these deposits is not known but may be as thick as 15 to 20 feet.

Damsite Foundation Conditions

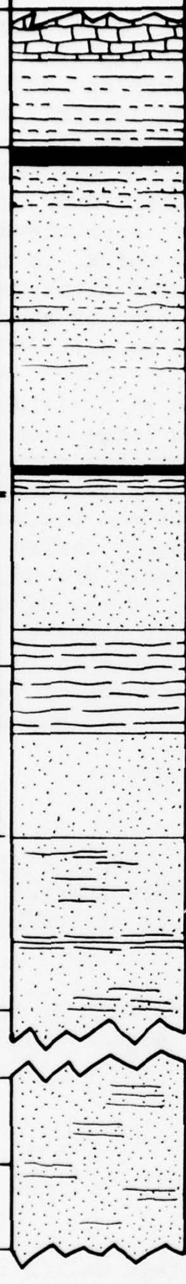
A total of three NXM core borings were drilled along the dam axis by the Corps of Engineers in 1967. The area was field-checked for outcrops and thickness of soils. Locations and the logs of the borings are shown on Figures 11-23 and 11-23a.

Sound rock appears to exist across the entire section at the proposed damsite. Consequently, it is concluded that a good foundation for a concrete dam is available.

Main Reservoir Condition

The St. Petersburg Dam would form a reservoir with a flood control pool elevation of 1155 feet.

The St. Petersburg site is in the moderately steep walled portion of the Clarion valley. Bedrock is exposed in the left valley wall from just above the streambed, elevation 875, up to elevation 1100. Above that elevation the ground flattens and bedrock was not seen. The rock in mainly sandstone, some of it in cross bedded layers an inch or so in thickness and other beds in more massive layers more than 2 feet thick. Well jointed sandy shale outcrops near streambed. Further up, near



ELEV.		STRATIGRAPHIC NAME	DESCRIPTION
		VANPORT LIMESTONE	HARD, FERRUGINOUS LIMESTONE
	ALLEGHENY FORMATION	SANDY SHALE	SANDY SHALE
1300	ALLEGHENY FORMATION	CLARION COAL	
	ALLEGHENY FORMATION	CRAIGSVILLE SANDSTONE	SANDY SHALE AND SOME HARD MASSIVE SANDSTONE
1250	ALLEGHENY FORMATION	AND SANDY SHALES	LOWER CLARION COAL MAY OR MAY NOT BE PRESENT IN THIS SECTION
	ALLEGHENY FORMATION	BROOKVILLE COAL & CLAY	COAL MAY NOT BE PRESENT
1200	POTTSVILLE FORMATION	HOMEWOOD SANDSTONE	COARSE GRAINED MASSIVE SANDSTONE, HIGHLY CROSS BEDDED AND OFTEN LOOSELY CEMENTED
1150	POTTSVILLE FORMATION	MERCER SHALE	SANDY SHALE AND SHALE SOME CARBONACEOUS AND CLAYEY SEAMS
	POTTSVILLE FORMATION	CONNOQUENESSING SANDSTONE	MEDIUM GRAINED QUARTZ SANDSTONE MAY BE SOFT AND CRUMBLY
1100			
1050		BURGOON SANDSTONE	THIN BEDDED SANDSTONE AND SOME INTER BEDDED SANDY SHALE. CONTAINS SOME THIN COAL AND CLAY SEAMS. MEDIUM TO COARSE GRAINED.
900			
RIVER EL.			FORMATION IS 300 TO 320 FEET IN THICKNESS.
850			

FIGURE II-24 GEOLOGIC COLUMN – ST. PETERSBURG RESERVOIR

elevation 1,040, dark gray silty to sandy shale about 30 feet thick is found on both sides of the valley. This shale is similar to the shale at the base of the left abutment of Mahoning Dam on which Monolith 18,160 feet high, was founded in April 1940. No soft shales or indurated clays were found. On the right bank along the road from the bridge at the gaging station northward toward St. Petersburg, cross bedded sandstone is exposed above elevation 1,100 from the small bridge in the ravine up to the corporate boundary. Thus the valley above streambed is a rock valley with thin soil cover probably less than 5 feet thick on the average up to elevation 1,100 but somewhat thicker above. No problem of reservoir leakage is anticipated.

Upper Reservoir Condition

The initially proposed area located at the top of a ridge adjacent to the left abutment of the dam, for the upper reservoir, as shown on Figure 11-27 is currently being strip mined. The elevation of the base of the coal is estimated to range from approximately elevation 1,280 ft. msl to 1,320. The coal dips to the south at about 20 feet to the mile. The stripping operation could result in about a 50 feet lowering (el. 1330 - el. 1280) of the area being considered for the upper reservoir. The foundation of the reservoir would be excavated into rock about 35 feet to elevation 1,245. The balance of the ridge south from the left abutment would be investigated for final upper reservoir location.

Power Station

Consideration had initially been given to an underground power station located along the left bank of the Clarion river about 3 miles below the main damsite, within the reach of the reregulation pool. However, cursory geologic study indicates that an underground facility at this location could result in costly construction problems because of the occurrence of Burgoon sandstone, into which the power station would be constructed. This stone is jointed and contains many planes of weakness so that it is doubtful for construction of the underground power station. It is for this reason that an "above ground" type power station was considered for design and cost. This will require additional study.

Tunneling through the sandstone is not expected to present any unusual difficulties for pumping and generating facilities involving a suction tunnel from the main reservoir to the power plant and a pressure shaft to the upper reservoir.

Availability of Construction Materials

Vanport Limestone, a source of concrete aggregate, is quarried at commercial quarries at Turkey City and nearby at Parker, Pennsylvania. These quarries are capable of furnishing suitable concrete aggregate in

adequate quantities within a very short hauling distance of the proposed dam and would make the cost of concrete reasonable.

Mineral Resources

Known mineral resources in the area of the project site are bituminous coal, oil and gas according to BOM Appendix I.

Coal mining is presently confined to the areas surrounding the reservoir where coal is recovered from the Clarion and Kittanning seams by strip methods. There has been no deep mining in the project area for more than 10 years. In the recreation area, there is a reserve of 61 million tons of coal in the Clarion and Kittanning seams, the only seams in the area considered to be economically mineable, of which about 16 million tons is stripable. The remaining 45 million tons, which represent potential reserves, would have to be recovered by deep mine methods. Recovery of these is presently uneconomical and relatively unneeded within the period to 2020.

Oil and gas have been produced in the area since before the turn of the century. According to available records the reservoir area contains a total of 347 wells of which 143 are abandoned, 60 are active oil wells, and 144 are gas wells; in the recreation and wildlife management area, there are 337 abandoned wells, 46 active oil wells, and 87 active gas wells for a total of 470. However, records are incomplete and a detailed field survey would be required to determine the actual number of wells in the project area.

The cost of acquiring coal reserves and oil and gas wells and leases required for the impoundment is estimated in Section IV allowing for continuation of strip mining and production of oil and gas in the recreation and developmental areas as mentioned above. Production of these minerals plays an important part in the present local economy.

A detailed report of mineral resources in the proposed St. Petersburg Reservoir area is included in Appendix I.

Conclusions

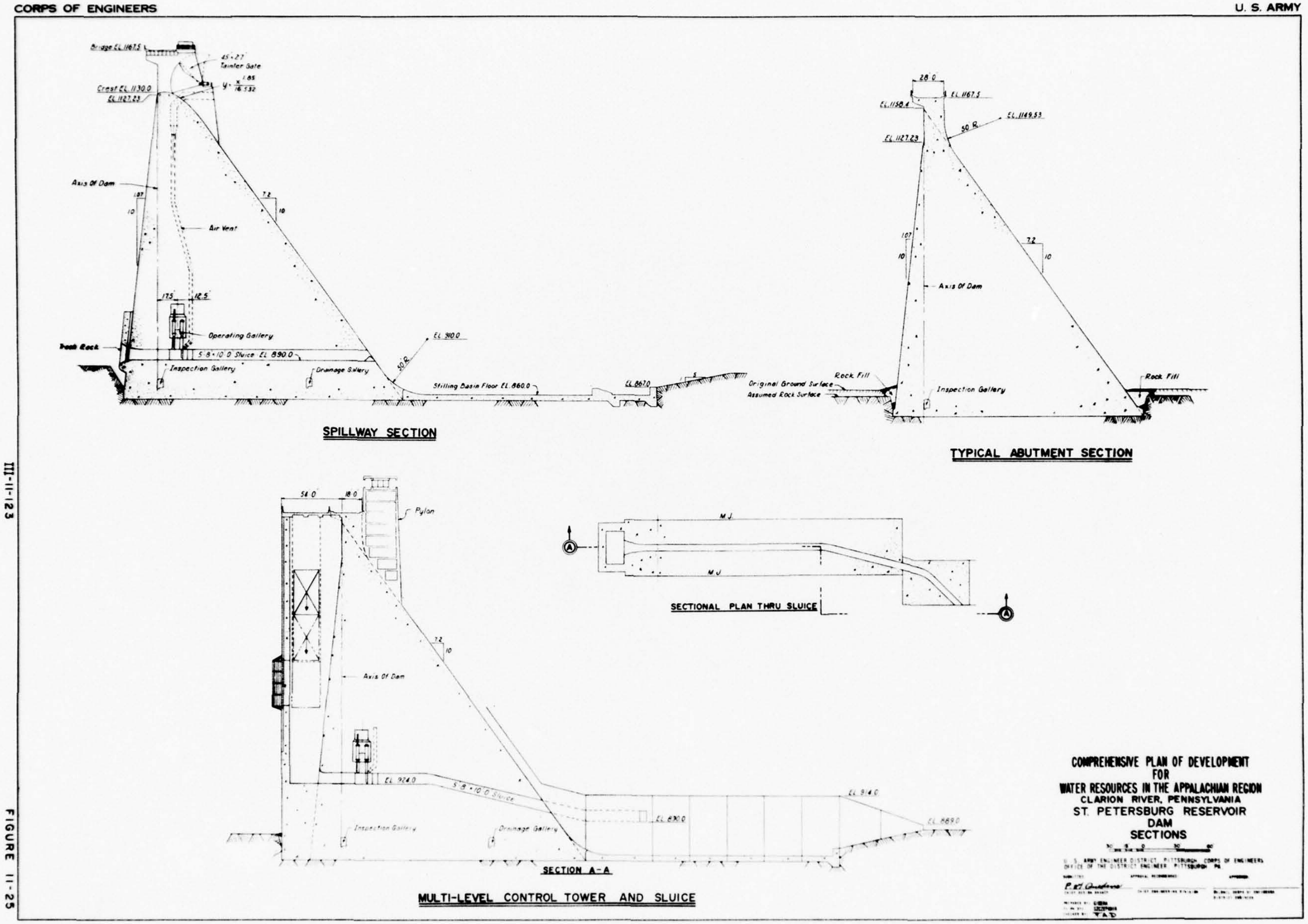
Because of the impervious nature of the underlying rocks and the extensive area coverage of these rocks, the damsite is well suited to the construction of a concrete dam, and the reservoir site to the size of impoundment formulated. An upper reservoir site for pumped-storage power generation and a power plant site can be suitably accommodated in the left abutment area. A suitable, economical source of concrete aggregate is available nearby. The foundation is adequate for the loads to be imposed.

13. STRUCTURAL

Structural features are shown on Figure 11-25. The dam would be a concrete gravity structure founded on firm rock, consisting of two abutment or non-overflow sections flanking a gated overflow or spillway section. Maximum height of the dam would be 288.5 feet, with the top of dam and roadway at elevation 1,167.5. The left abutment section would be about 683.5 feet long, the spillway section would be 363 feet long and the right abutment would be about 783.5 feet long, for a total length of approximately 1,830 feet. Final dimensions of the abutments would be determined upon completion of more accurate surveys and detailed foundation exploration after the project is authorized. The overflow section would be a controlled spillway with the crest at elevation 1,130 and having an ogee weir. The shape of the ogee weir would be designed in accordance with formulae shown in EM 1110-2-1603, Corps of Engineers, U.S. Army, using a design head (Hd) of 22 feet. The spillway control would be achieved with 7 tainter type, fixed trunnion crest gates, each 45 feet long and 27 feet high. The top of these gates in the closed position would be of elevation 1,157.0. A stilling basin, with paved floor, baffles, vertical end sill, and training walls would be provided downstream of the spillway section. Elevations and dimension for elements of the stilling basin are tentative. Final elevations and dimensions would be determined by detailed studies including model tests. Six sluices through the spillway at approximate streambed elevation, and one water quality control sluice in the left abutment adjacent to the spillway would be provided for control of reservoir pool elevation. The water quality control sluice would be used for discharging warmer water from the upper level of the reservoir for public use purposes. All sluices would be controlled by means of hydraulically operated slide gates located within the body of the dam. A service bridge across the spillway would be supported on six concrete girders. The roadway width on the service bridge and abutments would be 24 feet wide to serve as an element of a public access road to the recreational areas contemplated on the south side of the reservoir. Three-foot wide sidewalks would be provided at both the upstream and downstream sides of the roadway for pedestrian access. A lighted bridge type aluminum guardrail at the exterior edges of the sidewalks would furnish side protection. Operating equipment rooms with work, storage and office space would be provided in a pylon building constructed integrally with the dam on the downstream face of the left abutment adjacent to the spillway. A wet well type intake tower for the water quality control sluice would be constructed integrally with the dam on the upstream face of the left abutment, opposite the pylon building.

The interior of the dam would contain three main galleries, namely, an operating gallery with a service gallery for removal of equipment, an upstream inspection gallery, and a downstream inspection and drainage gallery extending through the deeper monoliths in the valley bottom. The operating gallery would be located over the seven sluices in the spillway section and would extend from a stairwell and elevator shaft at the pylon on the left abutment to a similar stairwell in the right abutment. This gallery would contain the operating chambers and sump pumps. The service gallery would extend from the operating gallery to the downstream face of the dam at the top of training wall level. An independent operating chamber with access from the left abutment stairwell and elevator would be provided for the water quality control sluice. The upstream or main inspection gallery would be located a short distance above foundation profile for the length of the dam. This gallery would contain the foundation drainage and grout piping, and sumps for the collection of leakage within the dam. The downstream inspection gallery would be located a short distance above the foundation of the deep portion of the dam near the downstream third point of the base width and would contain a drainage system. This gallery would drain into the sumps in the main gallery through drain pipes. Access to the main inspection gallery would be by means of the aforementioned stairwells as well as by two additional stairwells, one located near each end of the dam. Access to the downstream inspection gallery would be by means of a stairwell extending from the above cited service gallery.

It is contemplated that structural design relating to an upper reservoir and a power plant for hydropower generation would be performed in the pre-construction stage. Estimates of design and cost have been made from similar installations.


Bridge EL 1167.5
45 × 27 Tainter Gate
Crest EL 1130.0
EL 1127.23
Axis Of Dam
Air Vent
17.5
12.5
Operating Gallery
5.8 × 10.0 Sluice EL 890.0
Inspection Gallery
Drainage Gallery
EL 910.0
30 R
Stilling Basin Floor EL 860.0
EL 867.0
SPILLWAY SECTION
28.0
EL 1167.5
EL 1158.4
EL 1149.53
50 R
EL 1127.23
Axis Of Dam
Original Ground Surface
Assumed Rock Surface
Rock Fill
Inspection Gallery
TYPICAL ABUTMENT SECTION
54.0
18.0
Pylon
Axis Of Dam
EL 924.0
5.8 × 10.0 Sluice
EL 914.0
EL 890.0
EL 889.0
Inspection Gallery
Drainage Gallery
SECTION A-A
MULTI-LEVEL CONTROL TOWER AND SLUICE
M.J.
SECTIONAL PLAN THRU SLUICE
COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
CLARION RIVER, PENNSYLVANIA
ST. PETERSBURG RESERVOIR
DAM
SECTIONS
U. S. ARMY ENGINEER DISTRICT, PITTSBURGH, CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER, PITTSBURGH, PA.

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14. RELOCATIONS

Relocation work required by the proposed reservoir project has been coordinated with the Commonwealth of Pennsylvania and the various affected railroad and utility companies. Details are on file in the Pittsburgh District Office relative to design extent and estimates of cost. Two alternative relocation plans were considered and the best and cheaper alternate which was selected is shown on Figure 11-12. The first alternate considered replacement in kind of facilities which exist in the project area. A second alternative coordinated with the owning and interested parties was based on evaluation of future transportation and other facility requirements of the project area to lend support to a comprehensive development plan. Based on this coordination the second alternative was found to be more adequate for satisfying the formulated project and future needs of the area for economic development. An examination of possible highway possibilities to satisfy future road capacities and future developments led to a State-Federal devised highway plan which would effect a cost savings of $11,652,000 ($34,260,000 vrs. $22,608,000) over the first alternative on the highway plan alone, and would provide especially good mobility and access to the St. Petersburg site and to principal existing or potential developmental sites.

The selected plan of development would provide highway alterations and relocations related to Interstate 80 and Route 68 to maintain a desired rate of traffic flow in the vicinity of the project site. About 28 miles of new state and township roads and associated road improvements would be constructed. These are designed to State and Federal standards. A minimum number of new highway bridges would be provided across the reservoir for the relocations of the roadways, designed to carry traffic from I-80 across the top of the dam structure and to connect planned recreation areas by a circumferential access road. This road would continue on to Clarion, Pennsylvania. Two cross connections would be established in addition to bridging the reservoir at the damsite, between I-80 and Route 68 from Wentlings Corners to Zion Hill, and at Clarion, Pennsylvania. Abandonments would be held to a minimum to permit adequate circulation in the recreation areas and to continue access to active oil, gas and coal extraction areas.

Development of the impoundment would require relocation or abandonment of railroad facilities of the Penn-Central, and Baltimore and Ohio Railroads. Included would be construction of four new bridges and two tunnels of the Penn-Central and Baltimore and Ohio Railroads and abandonment of the Penn-Central Railroad tracks in the southern end of the reservoir at Sligo.

The Penn-Central Railroad relocation includes one of these bridges and two tunnels to maintain their line from Clearfield to Ashtabula for continuance of coal haulage and future possibility of providing rail freight from the project area to Lake Erie. Future studies would be made of line-consolidation possibilities and rerouting around the project area.

Utilities that would be affected by the project would be relocated or adjusted. These include approximately 19 miles of gas lines and about 12 miles of oil lines, and various power and communication lines and related facilities. An estimated 600 active and abandoned gas and oil wells in the impoundment area would be plugged. The Clarion Water Works, owned by the American Water Works Service Company, would require relocation to a higher site. Additional highway and utility relocations relative to the power plant and upper reservoir for hydropower involve several oil pipelines and plugging two oil wells, and a special access road.

Two public cemeteries, totaling about 1,000 graves, would require relocation.

15. Real Estate

Land considerations related to the project purposes for design and cost estimation follow prescribed policies for acquisition in fee title of necessary lands and improvements, and fee simple acquisition for lands needed for construction of the dam and appurtenant works. In summary, project requirements amount to 60,000 acres, distributed for the project uses shown in the detailed estimate of costs, Table 11-19.

Generally, land requirements for the proposed project were based on acquisition policies in accordance with ER 405-2-150, Planning and Project Authorization - Civil Works Projects, dated 11 February 1966. Land area required, on this basis, is 19,590 acres. The Clarion River Corridor requirements to provide requisite environmental and ecological protection to scenic, historic, archaeologic and conservation and scientific values, and to integrate the project into a more comprehensive State Park regimen, and possible inclusion into an Allegheny Interstate Recreational Complex (Pennsylvania and New York)1/, and to form a comprehensive unit with other upstream recreational river potentials in the Clarion River, amount to 12,000 acres. A variety of miscellaneous project purposes and reservations for a land bank area to meet unpredictable future requirements, including the possibility of relocation of project displaced persons, would require 1,600 acres. The aggregate of such joint use lands totals 33,190 acres. Specific recreation purposes, to be commensurate with Commonwealth of Pennsylvania criteria for recreational development for use of large urban areas, would require acquisition of 16,000 acres of land. To mitigate losses incurred by project development, for a continuation of wildlife opportunities, 10,300 acres would be ascribed to wildlife management. 530 acres of land would be required for a combination of power facilities.

Some portions of the lands acquired for recreation or other project purposes contain coal reserves of national value.2/ Extraction of these reserves would be permitted with state controls effected relative to acid mine drainage prevention and reclamation of the land to suitable contours for project use.

1/ Appalachian Highlands Recreation Study.
2/ See U.S. Bureau of Mines, Appendix I.

16. HYDROELECTRIC POWER EVALUATION

Hydroelectric Power Unit

The entire repertory of pumped-storage hydropower facilities which constitute the power unit of the formulated project would be incorporated into an area just southeast of the damsite and contiguous to Site 1 in the recreation plan, as shown on Figure 11-26. The combination of contemplated recreation and power facilities in this location would be compatible with maximum development of the project area. Components of the power plan derive from a joint formulation study of Plan B with FPC with adjustments of the plan to give more flexibility of operation for maintenance of optimum seasonal recreation pool levels and to compensate for a slight loss in expected head due to strip mining activities. In the upper pool area originally contemplated, the upper reservoir sited on Figure 11-27 would store about 15,500 acre-feet, and cover a storage area of about 220 acres. Consequently, Plan B as modified and rearranged to accomplish these objectives without decreasing installed capacity or yearly generation values, is described below.

The entire power package is located on the area involving a strip of high plateau and abruptly steep hillside falling to the Clarion River southeast of the left abutment of the dam. Topography and the return meander of the river permit economy and flexibility of siting of the upper reservoir, connecting tunnels, and the power plant. Strip mining of coal in this area, which is a factor relative to the effective pumping and generating heads, has progressed at the original site of the upper pool to the extent that there has been some 20-foot lowering of the natural ground level, with the expectation that the base of the coal seam being removed will eventually cause cutting to about elevation 1,280. This is at the site which would require the shortest lengths of suction and power tunnels. To establish optimum head conditions in the upper pool reservoir at elevation 1,320 at this site, it would require that excavation be made into rock to a depth of about 35-feet, and construction of a rock-earth fill dike about 45-feet high, using the excavated rock as dike material. The capacity-generation-cost relationships, and net benefits, are not expected to be altered. However, alternative site study would be needed relative to other sites for evaluation of costs relative to upper reservoir capacity, elevation of upper power pool, and combinations of lengths of suction and power tunnels required. There appear to be satisfactory alternative power plant sites along the left bank of the Clarion River below the main dam and within the reregulation reservoir reach, which have comparable development characteristics, if resiting of the upper power reservoir would be desirable. An afterbay arrangement of the main reservoir would connect by tunnel to the power plant at the river's edge.

CORPS OF ENGINEERS U. S. ARMY

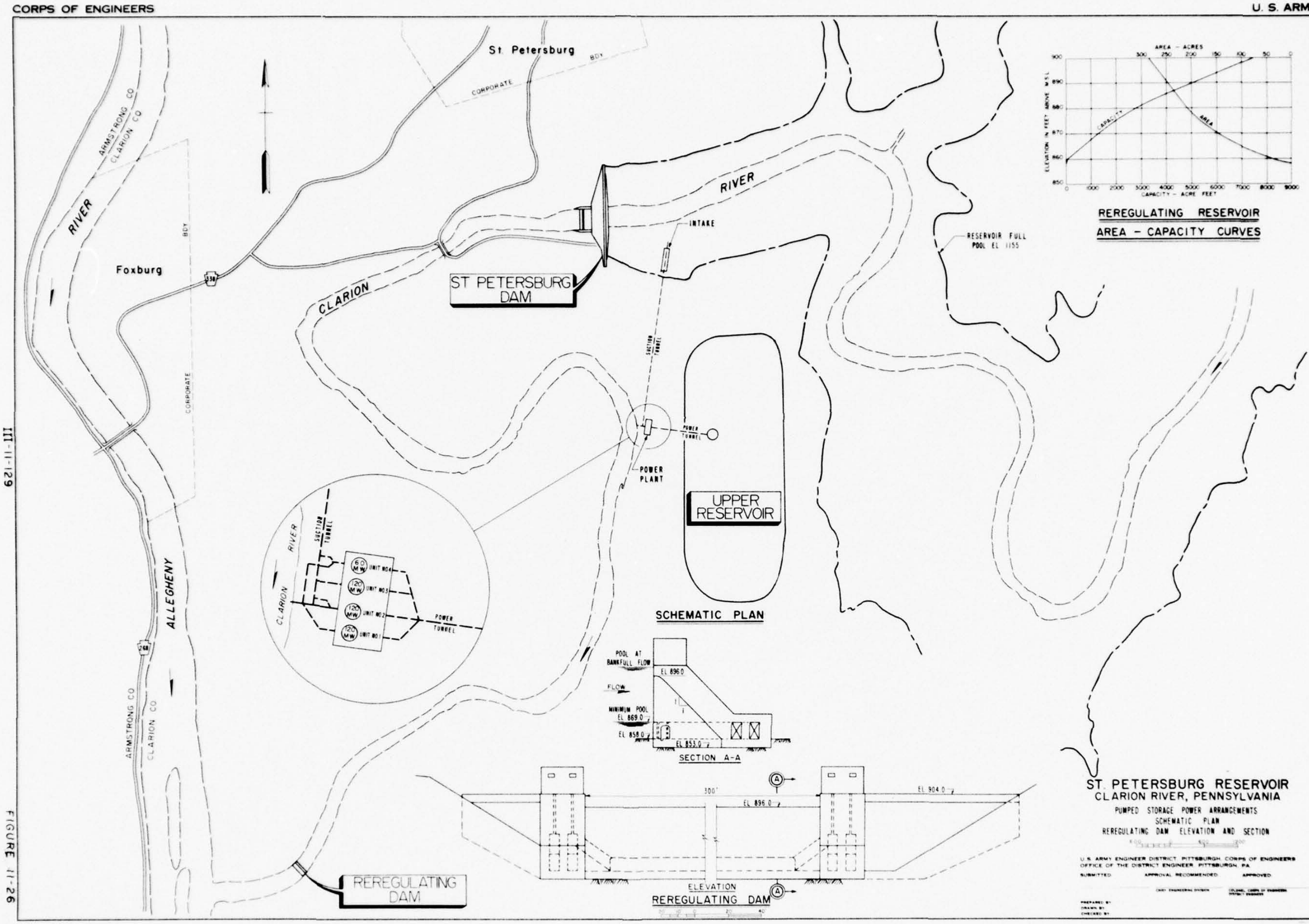

FIGURE 11-26

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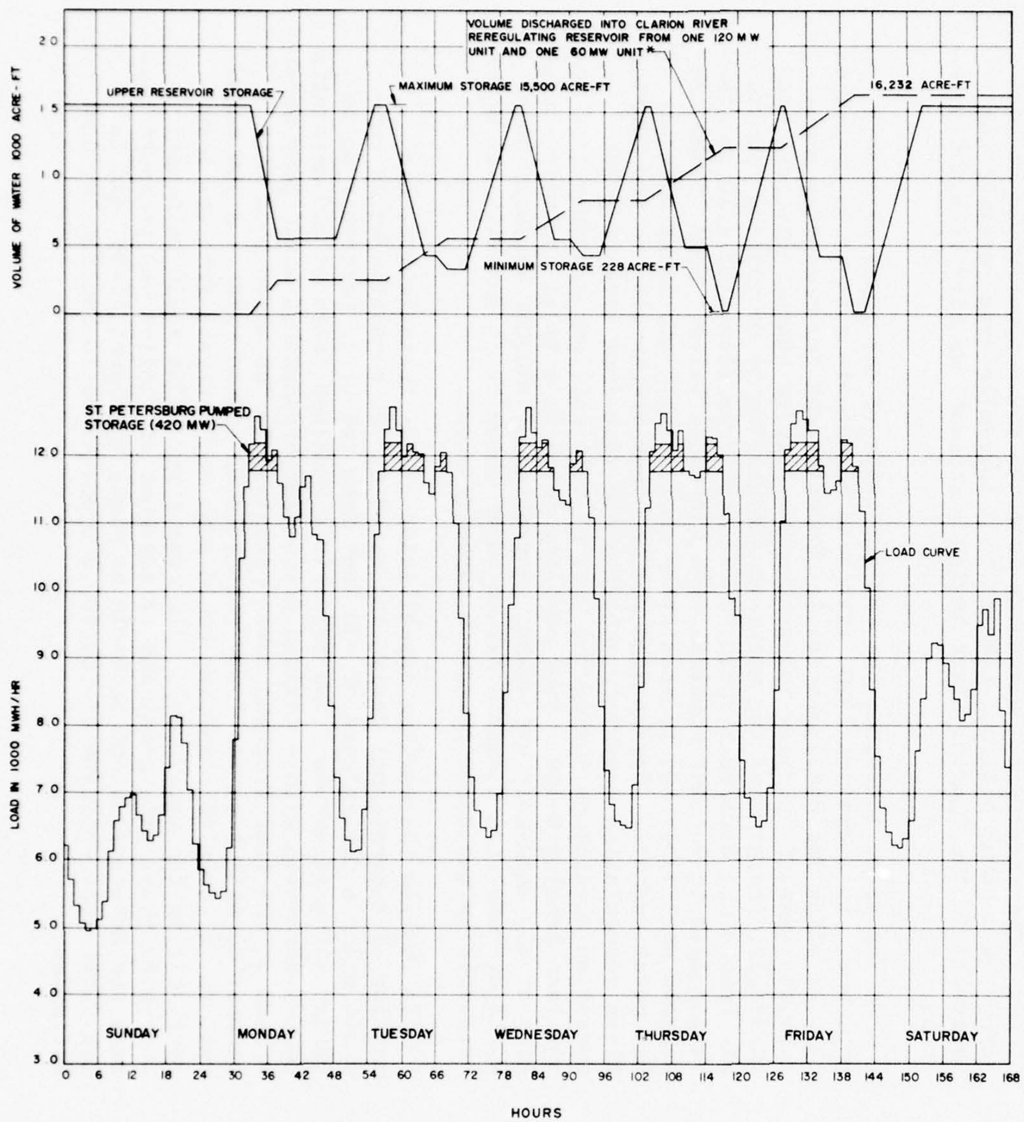


NOTES

1. THE LOAD CURVE IS AN ASSUMED HOURLY LOAD CURVE DURING A CRITICAL WEEK IN THE ASSUMED ON-LINE YEAR OF 1985. IT IS BASED ON MARKET DATA OBTAINED DURING PREVIOUS STUDIES OF HYDROELECTRIC POWER POSSIBILITIES IN THE GENERAL AREA. IT IS CONSIDERED TO REASONABLY REPRESENT A PORTION OF SUPPLY AREA 5 THAT COULD ABSORB THE POWER PRODUCED AT ST. PETERSBURG RESERVOIR.

2. TOTAL STORAGE OF UPPER RESERVOIR, INCLUDING DEAD STORAGE, IS 15,500 ACRE-FEET.

3. DURING THE WEEK OF CRITICAL LOAD, 16,232 ACRE-FEET OF POWER DISCHARGE WOULD ENTER THE CLARION RIVER REREGULATING RESERVOIR. THIS VOLUME, REGULATED BY THE REREGULATING DAM OVER A SEVEN DAY PERIOD, WOULD YIELD AN AVERAGE FLOW OF 1170 CFS.

4. DURING A WEEK OF AVERAGE LOAD, ONLY 14,580 ACRE-FEET OF WATER WOULD BE DISCHARGED INTO THE RIVER, RESULTING IN AN AVERAGE RELEASE OF 1,050 CFS AT THE REREGULATING DAM.

* TWO 120 MW UNITS DISCHARGE ONLY TO MAIN RESERVOIR

ST. PETERSBURG RESERVOIR
CLARION RIVER, PENNSYLVANIA
PUMPED STORAGE POWER
HOURLY LOAD PATTERN
AND
PUMPED STORAGE GENERATION
THROUGH
CRITICAL WEEK

The illustrated arrangement of storage, pumping and generating facilities including location and lengths of suction and power tunnels and tailrace, and power plant location is somewhat similar in concept, arrangement and location with that of FPC Plan "B" based upon formulated criteria for reservoir levels and releases (FPC letters dated 21 December 1967 and 17 March 1969 on file in District Office, Corps of Engineers, Pittsburgh). The total rated installation of 420 megawatts which would provide an annual generation of 650,000 megawatt-hours pertains to the plan adopted herein.

Plan Layout

The arrangement and distribution of water storing, pumping and electrical generating components of the plan are shown on Figure 11-27. The powerhouse would be located above ground at the river edge about 2.8 miles below the main dam with 3,300 feet of suction tunnel from the St. Petersburg Reservoir and a sloped 1000-foot length pressure tunnel to the upper reservoir. Discharge from the power plant would be conveyed via a paved tailrace channel to a four-mile long reregulating reservoir in the Clarion River having a storage capacity of 4,800 acre-feet.

At the sited location, the maximum level of the upper reservoir pool would be elevation 1320, with head computations based on elevation 1310 to allow for contingencies in operation and for presently undetermined specific pumping and generating machine characteristics. Accordingly, design head for machines discharging to or pumping from the St. Petersburg Reservoir would be 195 feet from elevation 1310 to elevation 1115 in October critical week discussed below. Head losses are assumed negligible due to relatively short length and large diameter of the power tunnels. Design head for machines discharging to the Clarion River reregulating reservoir would be 430 feet from elevation 880. Operation conditions during the week of critical load are described under that heading below. Four machines rated at a total installed capacity of 420 megawatts and annual generation of 650,000 megawatt-hours would operate in a flexible system under these heads and with the water availability and upper reservoir capacity shown.

To realize the maximum capabilities of the installation, one machine of conventional design and rated at 120 megawatts would generate under a design head of 430 feet from the upper reservoir to the reregulating reservoir. Two reversible machines rated at 120 megawatts and 60 megawatts with a divided draft tube arrangement would pump under a head of 195 feet from the lower reservoir to the upper pool with generation either to the lower reservoir or to the river. A 120 megawatt rated reversible machine would pump and generate from the lower reservoir to the upper pool. All four power units would be housed in the power plant with requisite arrangement of suction and pressure tunnels and accessories and controls as shows on Figure 11-26, and in the first cost estimate of $60,700,000 contained in Section IV, Cost Estimates.

The described plan would assure dependable power without adversely affecting other project purposes. The reregulating dam and reservoir, with damsite about one mile above the river mouth would permit power discharge reregulation for low-flow augmentation downstream for water quality. Differences from Plan B described in the formulation procedures are mainly functional and locational. Decision as to whether the power plant would be located underground just southeast of the dam or above ground at the river edge as shown, is largely a geologic matter which for resolution will require detailed subsurface data which are not available at this time. Both plan arrangements and power plant locations in various combinations would yield the maximum hydropower potential of the multiple purpose project.

Relocations

The additional relocations to accommodate the plan described above would be relatively minor. Several oil pipelines would require relocation. Two oil wells would be plugged. Costs of these are included in Table 11-20, Section IV.

Real Estate

The land required for the pumped storage installation would consist of approximately 400 acres for the upper reservoir and power station and appurtenances, a 100-foot flowage strip (120 acres) along both banks of the Clarion River for the reregulating reservoir, and approximately 10 acres for the reregulating dam. Costs for these lands are included in Table 11-20, Section IV.

General Plan of Operation

The scheme of operation of the pumped-storage facilities would be based upon pumping water from the St. Petersburg Reservoir (afterbay) at night when the demand for power from available steam plant capacity in the area system is low, and releasing water from the upper reservoir (forebay) for generation into the area system during daylight hours, when the demand for energy is high. Some of the power discharges would be made to the river and some to the reservoir depending upon storage and inflow and seasonal recreation and low-flow augmentation requirements. To analyze operation of the power system, the total installation was sized for a daily cycle, i.e., that the upper reservoir storage used for generating on any given day would be replenished by pumping during the following night.

Operation during Critical Load Conditions

Figure 11-27 shows an hourly load curve determined for a week of critical demand in the area system to reflect an assumed online year,

in this analysis - 1985. This curve was estimmted by projecting data that had previously been furnished by FPC in connection with past studies of pumped storage installations in the general closeby area. This critical week load curve is considered to be representative of the portion of supply area No. 5 that would serve as the market for power produced at the St. Petersburg site. Available data for the market area indicates that the critical week would probably be in October. In this month, the pool elevation of the St. Petersburg Reservoir would be between elevation 1115-1130.

The assumed position of St. Petersburg's potential 420 megawatt capacity in the area system load curve would furnish the probability that this power installation could be directed to generate power

amounting to the following energies and for the durations tabulated during the assumed critical load week:

	Generation	
Day	Energy	Equivalent Hours of Full Load Generation at 420 mw
Monday	2,200	5.2
Tuesday	2,700	6.4
Wednesday	2,450	5.8
Thursday	3,350	8.0
Friday	3,350	8.0
Total	14,050	33.4

No power generation would be required on Saturdays and Sundays because the existing supply would be capable of meeting relatively low demands on these days.

During the critical load week, it was assumed that during the generating cycle Units No. 1 and No. 4, a total of 180 mw, would discharge to the river under the head of 430 feet, and that Units No. 2 and No. 3, a total of 240 mw, would discharge back to the reservoir under the head of 195 feet. During the pumping cycle the reversible units, Nos. 2 and 4, a total of 300 mw, would return water to the upper reservoir against the head of 195 feet.

Under these condtions, for each hour of generation, 486 acre-feet of water would be released to the river and 1,423 acre-feet of water would be returned to the St. Petersburg Reservoir. A total of 1,909 acre-feet would accordingly be required for each hour of generation at

the rated capacity of 430 mw. The capability of the machines for returning water to the upper reservoir would be 1,419 acre-feet for each hour of pumping time.

The pumped-storage operation during the critical week is tabulated in Table 11-17 and shown graphically on Figure 11-27. The storage capacity of the upper reservoir, 15,500 acre-feet, which appears to be about the most that could be provided at the site presently considered, would be sufficient to support generation on a day of maximum demand when 15,272 acre-feet of upper reservoir storage would be required. The 16,232 acre-feet of water released to the Clarion River reregulating reservoir over the five-day period would be distributed to the Allegheny River at the mouth of the Clarion River from the reregulating reservoir over a seven day period, to yield an average flow of 1,170 cfs over the critical load week.

Operation under Average Load Conditions

The St. Petersburg pumped-storage power development was sized such that it would be capable of fully meeting the demand of the critical week and critical day comprising 33.4 and 8.0 hours of full-load generation, respectively. However, it is recognized that because of fluctuations in the market demand, the St. Petersburg pumped-storage installation would not have to operate at these maximum durations for every week of the year. The load duration curve for an average week, with St. Petersburg power positioned theron, indicates as shown on Figure 11-28, that the average weekly duration of generation would be approximately 30 hours. Although it is recognized that an hourly-load pattern for the average load week is not presently available, it has been assumed for this analysis that the 30 hours week duration would be comprised of 5 days at 6 hours of generation per day. The pumped-storage operation during the average load week is summarized in Table 11-17a. As indicated, this operation would discharge 14,580 acre-feet of water into the Clarion River reregulating reservoir. This storage would be then distributed by the reregulating dam over a seven day period, yielding an average flow of 1,050 cfs. To replenish the storage in the upper reservoir, 40.5 hours of pumping would be required at the full pumping capacity of 300 mw. The flows determined are entirely compatible with other purpose usage.

TABLE 11-17

PUMPED STORAGE OPERATION DURING
WEEK OF CRITICAL LOAD (PROJECTED 1985 CONDITIONS)

Day Column (1)	Equivalent Hours of Full Load Generation at 420 mw (Hrs.) (2)	Volume of Water for Generation: (Acre-Feet) Total (3)	Portion Returned to St. Petersburg Reservoir (4)	Portion Released to Clarion River (5)	Pumping Time (Hrs.) (6)
Monday	5.2	9,927	7,400	2,527	7.0
Tuesday	6.4	12,217	9,107	3,110	8.6
Wednesday	5.8	11,072	8,253	2,819	7.8
Thursday	8.0	15,272	11,384	3,888	10.8
Friday	8.0	15,272	11,384	3,888	10.8
Total	33.4	63,760	47,528	16,232	45.0

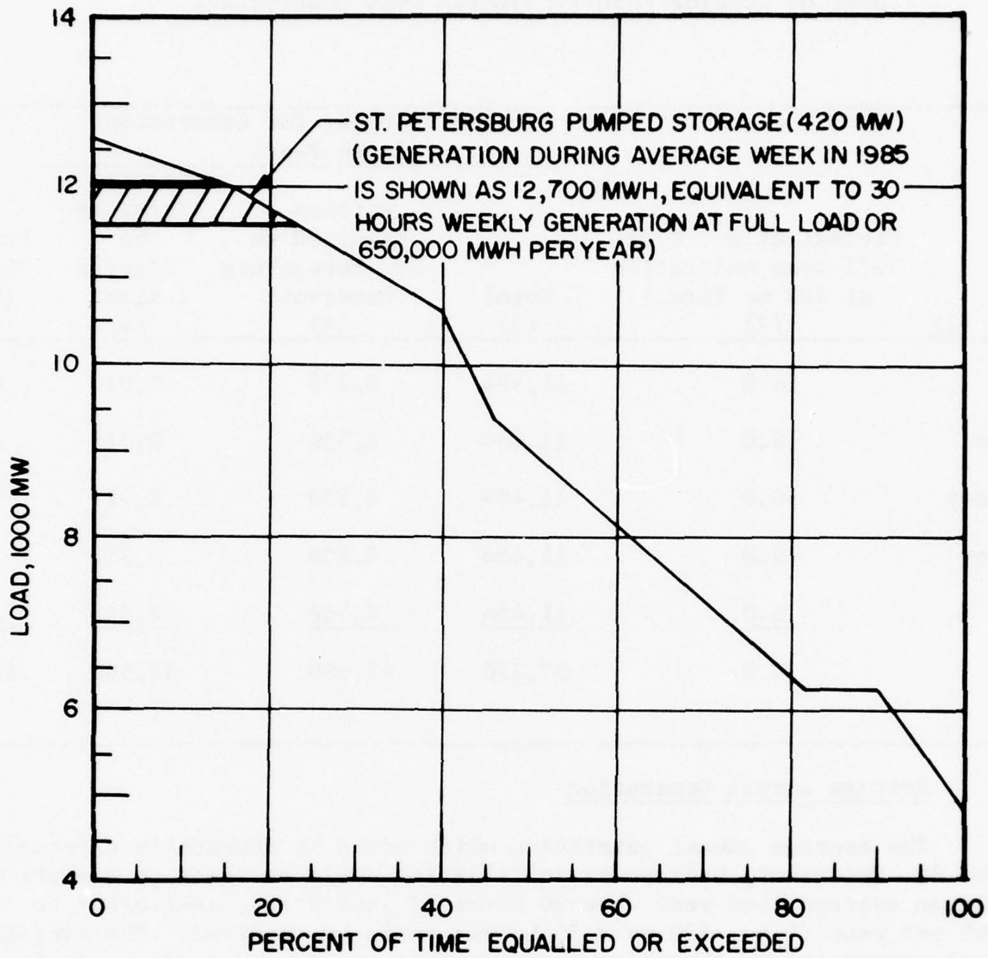
Sample Calculations for Monday:

Col (3): 1909 AF/hr x 5.2 hrs. = 9,927 AF

Col (4): 1423 AF/hr x 5.2 hrs. = 7,400 AF

Col (5): 486 AF/hr x 5.2 hrs. = 2,527 AF

Col (6): 9927 AF - 1,419 AF/hrs = 7.0 hrs.



ST. PETERSBURG RESERVOIR
CLARION RIVER, PENNSYLVANIA
PUMPED STORAGE POWER
AREA LOAD DURATION CURVE
FOR AVERAGE WEEK

FIGURE 11-28

TABLE 11-17a

PUMPED STORAGE OPERATION DURING
WEEK OF AVERAGE LOAD (PROJECTED 1985 CONDITIONS)

Day Column (1)	Equivalent Hours of Full Load Generation at 420 mw (Hrs.) (2)	Volume of Water for Generation: (Acre-Feet) Total (3)	Portion Returned to St. Petersburg Reservoir (4)	Portion Released to Clarion River (5)	Pumping Time (Hrs.) (6)
Monday	6.0	11,454	8,538	2,916	8.1
Tuesday	6.0	11,454	8,538	2,916	8.1
Wednesday	6.0	11,454	8,538	2,916	8.1
Thursday	6.0	11,454	8,538	2,916	8.1
Friday	6.0	11,454	8,538	2,916	8.1
Total	30.0	57,270	42,690	14,580	40.5

Average Annual Generation

The average annual generation which would be dependably expected from the St. Petersburg hydropower installation would be based on operation during an average load week when 30 hours of generation, equivalent to 12,600 mwh per week (i.e., 420 mw x 30 hours) would be required. The average annual generation is therefore considered for study and economic analysis reasons to dependably be 650,000 mwh (i.e., 52 weeks x 12,600 mwh/week).

Plant Factor

The annual plant factor is defined as the ratio of the average load on the plant over the period of a year, to the aggregate rating of all the generating equipment installed in the plant. As previously discussed, the average annual generation from the St. Petersburg pumped-storage installation would be 650,000 mwh, which is equivalent to an average load on the plant of 74.2 mw (i.e., 650,000 mwh + 8,760 hours/year). The average annual plant factor would therefore be the ratio of 74.2 mw to 420 mw, or 17.7 percent.

Energy Required for Pumping

The previously indicated 40.5 hours of pumping would be required at full pumping capacity of 300 mw during an average load week. On a yearly basis, the pumping energy required would be approximately 63,000 mwh (i.e., 300 mw x 40.5 hrs/week x 52 weeks.)

Power Values

The annual power values employed in the economic analyses herein are based on unit costs of alternative steam capacity established in 1966 for the Appalachian Region Studies. These at-site power values, based on private financing are $17 per kilowatt-year for dependable capacity and 2 mills per kilowatt-hour for energy. Annual specific power costs are based on Federal financing with fixed charges at 4.67 percent for power facilities, 3.44 percent for dams and reservoir, and pumping energy at 2.6 mills per kilowatt-hour.

Price levels used in Section IV in project cost estimates are as of July 1967. Therefore, no change is necessary in power values. These at-site values are comparable to the at-market power values shown in Appendix B, after allowance for transmission liabilities associated with the project installation and the steam-electric alternative.

General Limiting Factors

The above discussions are relevant to preliminary estimates of water storage requirements and water-use at a formulated level of generation and energy output from the power installation determined jointly between FPC and CofE. Additional detailed site explorations and design studies would be necessary to establish the optimum for a project development which would include power. Specific machine selections were not considered although in a first analysis (31 July 1967 FPC letter) pumped-storage generation values were based on Dariaz type units which have adjustable blade reversible turbines. However, further investigation of the characteristics of Dariaz turbine units manufactured by the English Electric Company as well as other manufacturers machines would be required. In arriving at levels of potential power development at the St. Petersburg site joint consideration was made of plans for conventional power development at the concrete main dam or by pumped-storage means alone and with combined conventional power at the pumped-storage power plant site.

An economic analysis was also made of each scheme utilizing power values derived from a privately financed pumped-storage alternative. It was found that although the power benefits were considerably reduced, the resulting benefit-cost ratios were substantially greater than unity. It was also found that the incremental capacity difference (270 megawatts) between the two plans is economically justified.

Based on the results of our studies, it is concluded that either a conventional or pumped storage power installation is economically feasible as part of the St. Petersburg multiple-purpose reservoir. It is further concluded, that additional detailed studies of the project and the suggested plans for power development, are required in the design stage in order to establish, more definitively, power costs and benefits as well as the appropriate installation for the market to be served.

In recapitulation, FPC after receiving a CofE request for review and updating of suggested power plans, reaffirmed that there were no valid reasons for changing previous conclusions that the development of hydroelectric power at the St. Petersburg site would be economically feasible. It is further noted that the electric utility representative in his testimony at the public hearing (see Section VIII) on the project, reached a similar conclusion.

The physical and economic interdependence relevant to integrated operation of the pumped-storage facility and the St. Petersburg project for other purposes, established that the contemplated utilization of St. Petersburg Reservoir and the power discharge reregulating reservoir as afterbay for the pumped-storage (or conventional power) facilities, would require effective coordination of power operation with that for other purposes to assure the full effectiveness of the project.

Effect of Power Operation on Water Quality Control Discharges

As previously indicated and as shown on Figure 11-27, it would be necessary that 16,232 acre-feet of water be discharged to the Clarion River reregulating reservoir from the power operation during the critical load week and 14,580 acre-feet during the average load week. These volumes from storage would be regulated at the reregulating dam with resulting average releases, over a seven-day period, of 1,170 cfs and 1,050 cfs., respectively. These power discharges would be supplemented on rare occasions, if necessary, by releases from storage to meet downstream low-flow augmentation requirements for water quality.

Effect of Power Operation on Recreation

In the sizing of the pumped-storage installation previously discussed, it was necessary to first determine the permissible power yield (cfs) from St. Petersburg, that would not cause reservoir drawdowns detrimental to recreation. As indicated in the discussion on recreation, recreational benefits are essentially maximized with seasonal recreation pool levels ranging from elevation 1,130 to a minimum of elevation 1,115, during the period of maximum summer recreational use, and a further minimum of about elevation 1,110 through the winter recreation season. This permissible power yield was determined to be about 1,200 cfs. A reservoir operation study using a continuous reservoir yield of 1,200 cfs, the results of which are shown on Figure 11-9, indicates that over the 37-year period of analysis (1929-1965, inclusive) the

reservoir pool levels for recreation would be maintained. It is concluded that power discharges 1,170 cfs and 1,050 cfs during the critical and average load weeks, respectively, would not reduce the recreational value of the reservoir during the period of maximum recreational use.

Figure 11-9 also shows the effect of the 1,200 cfs continuous yield on the yearly reservoir drawdown. It shows, as indicated herebefore, that the reservoir pool would only rarely, if permitted, drop below elevations formulated for optimum recreational use of the reservoir. It should be recognized, however, that the actual power discharges, as previously discussed, would be less than 1,200 cfs and accordingly the actual drawdowns would be less than that shown on Figure 11-9. The study situation is considered conservative. In addition, the pumped-storage installation as described above, would have the added capability of reducing the draft on storage and resulting drawdowns by varying amounts of discharges to the river and discharges to the reservoir during the periods of power generation.

Site Capability

Power needs for the area are considerably high as reflected in the discussion of projected needs for additional hydroelectric power in Supply Area No. 5. FPC advised that the site power producing potential be maximized. Two factors limit the site capability; size of the upper reservoir, and drawdown limits imposed by recreation optimization. The latter item has been investigated in the formulation stage. The former is discussed further below with contingent items.

Upper Reservoir

As mentioned, the area preliminarily studied for the upper reservoir is currently being strip mined. The elevation of the base of the coal is estimated to range from approximately elevation 1280 ft. to elevation 1320. The dip of the coal seam is to the south at about 20 feet to the mile. At this time, it appears that continuation of the stripping operation could ultimately result in about a 50 foot ground-surface lowering (el. 1330 to el. 1280) of the area being considered herein for the upper reservoir. The foundation of the upper reservoir would be excavated into rock about 35 feet to about elevation 1,245. Future study of the area adjacent to the left abutment of the dam, would establish a firm location for the upper reservoir at its optimum size.

Power Station

Consideration had initially been given to an underground power station which would be located adjacent to the northwest and of the upper reservoir with a vertical pressure shaft connecting the structures. However, some further geologic study indicates that an underground facility may result in more costly construction problems because the

Burgoon sandstones, into which the power station would be constructed, may be jointed and may contain planes of weakness. If so, it is somewhat doubtful that this sandstone would have the capability of spanning the opening required for construction of the underground power station. It is for this reason that the power station, as considered, is situated above ground for this study.

Tunneling

It is not expected that tunneling through the sandstone would present any unusual difficulties. Detailed geologic studies for the area would also fully resolve this matter.

Access

Adequate access to the upper reservoir area would be provided by the proposed two-lane highway that would cross the St. Petersburg damsite and continue southeasterly approximately along the alignment of existing Legislative Route No. 16109. This highway which would be required as part of the multiple-purpose project, would also serve the power development. In addition, however, a special access road would be required from the two-lane highway to the power station.

Cost Estimate

A complete cost evaluation of the power development is contained in Section IV. Total estimated cost is $60,700,000. Annual cost is $4,780,000.

Benefit Estimate

Benefits attributable to power are shown in Section V. These amount to $8,440,000 annually. It is indicated that, the project would be economically feasible without power. However, this does not agree with the general economic development concept of this study, or with multiple-purpose water resource development objectives.

Power System Utilization

With the final determination of project feasibility, the pumped-storage installation could be applied to the reservoir project after it is constructed. The General Public Utility System has indicated its interest in this development, with recapture of their Piney Hydroelectric Project No. 309 License. In the preconstruction stage, it would appear desirable to test out the project pumped-storage power potential under that System's own conditions of load, utilization and upper reservoir storage and draft requirements and time-phasing of development. In this respect, the System would be called upon to develop the standard pumped-storage project data, electric and hydraulic, such as:

a. Magnitude of its present load and its load factor; combined system load curve for weeks of maximum demand; system load duration curve for peak-load weeks, and peak % curve for peak-load week.

b. Size, shape, and characteristics of company load data for about fifteen years previous, including estimated loads and outputs for peak-weeks and normalized weeks, outputs and capacity data on existing hydropower, and combined power system annual and weekly load factors.

c. Projected load growth (load predictions from 1980), and projected system growth.

d. Present system: location, size, interconnection and characteristics of existing plants.

e. Reserve capacity available in system, and possibility of pumped-storage replacing existing reserve steam capacity more economically.

f. Connection to electric transmission system and utilization of capacity of potential power development.

g. Time within which the pumped-storage development could be utilized.

h. Available (location), or proposed, low-cost off-peak and on-peak, to other utilities and cooperatives.

i. Possibility of sale of power produced, both off-peak and on-peak, to other utilities and cooperatives.

j. Determination of annual cost per kilowatt, including number of hours of peak-load generation, and value of this service to interconnected system as measured by cost of alternative new steam capacity and effect on other system production costs.

k. Transmission facilities of system, and costs.

All or part of such data as mentioned above, would result in a better rounded economic study and discussion of the impact of a potential pumped-storage development on the entire St. Petersburg project and project area, both as to a potential Federally or a potential privately financed power project. It would also answer the following questions as relevant to the scope of study by the power system:

1. Is pumped-storage peaking power economic for the system under the conditions and limitations imposed by the project operation data and criteria for other purposes contained above (and any other appurtenant system data which may be necessary to the study)?

2. What is the optimum level of pumped-storage power?

3. What is the relation of the optimum value to that value which would make use of the maximum storage possible in the potential main reservoir?

4. What are the power values determined by system experience?

17. ENVIRONMENTAL FEATURES

The environmental resources planning aspect of the Clarion River Basin in many respects is simplistic, amounting to interrelating its variant but few ecologies. The lower end of the river valley displays all evidences which have present-day economic overtones. To the northeast following the river, but embraced within the same geological and environmental stratigraphy, the valley resources have been preserved by the retention of a few stands of the virgin timber resource at Cook Forest and other lesser forest lands by the Commonwealth of Pennsylvania. A semi-primitive character remains in the Allegheny National Forest which is wetted by the north bank of the river. There are about 35 miles of more or less roadless river valley from Cook Forest to Ridgway. These few variances distinguish the opportunities for environmental changes as well as for preservation to best appreciate the whole gamut of the valley's environment. The changes which have taken place to despoil the character of the lower valley at the location of the St. Petersburg Reservoir may, in the final analysis, be more creative than destructive. Within the range of the existing environment, good and bad, there has been created the opportunity to be selective, to assume the freedom to experiment, to revise the detrimental and to adapt the remaining natural resources to a new and better environment.

Efforts at preservation of the river's resources have not been deliberately undertaken for any uniquely different or outstanding purpose, but provide for a continuing watershed development via State and Federal efforts for establishing facilities needed in the mushrooming recreation, and conservation appreciation and education sectors. The indirect value of the basin retained exclusively as a watershed cannot be minimized. The charm of the river basin has evoked accolades concerning its array of majestic landscape features as a part of Penns Woods West. However, economic pressures, from frontier days on, have so altered the resource in the contemplated impoundment area that the objective now is for planning to heal the scars on the landscape, abate water pollution, and examine the area in the light of multiple-use in the face of the reality that the need for recreation and economic development will grow. The situation as it now relates to the Clarion River area indicates that there are pressures for change to the end that it will probably grow to the point that the need for recreation and environmental appreciation may exceed or at least be severely competitive with all other economic benefits.

The Clarion River is distinguished by its numerous, very long curves where the river doubles back on its course time and again, hemmed in by rock formations which are lightly soil covered and not always evident. Its meanderings have cut an awesome canyon-like valley which contrasts with its stream cut terraces and abandoned channels along the lower river valley, especially in the Callensburg area where the broad and relatively flat areas would form the main body of the St. Petersburg impoundment. This area possesses the bulk

of the exploitable resources and extends upstream to about Cooksburg, with population concentrations which hedgehop along the river from Foxburg to Clarion, Pennsylvania. The intriguingly shaped water impoundment which could be placed into this environmental setting would most fully comply with the economic development concept provided herein from the view that the project in itself would attract thousands of people to spend much of their leisure time in this mountainous, forested area. The revenue from this would be big business and certainly has prospects for getting bigger.

The recreation plan described below is conceived as an integral part of an environmental resource development to enhance the visual beauty of the area, to afford a contrast which will reflect the crystal-like character of the vari-shaped water areas against the reclaimed beauty of the upper plateau areas and natural beauty of the more rugged forested areas. Clusters of developments of different characters are designed around the multiplicity of land and water shapes to satisfy and increase the enjoyment of the various population segments whose recreation and aesthetic tastes vary from the primitive to the ultra-sophisticated. To accomplish the utmost in distinguishing the physical and recreational values of individualized general outdoor recreation siting possibilities, there are nine specific clusters of areas which are envisioned for their singularity of water and land forms and useage, natural and scientific values, educational and other cultural values, and their potential as a framework for Government and private investments in recreation oriented toward further economic developments. Combined into these areas for concept evolution are the basin and impoundment area resource assets and liabilities which could be adapted to environmental betterments by their employment to their fullest use.

Environmental Influences

Viewing the St. Petersburg Reservoir project site from the skyline juncture of the canyon-like gorges of the Allegheny and Clarion Rivers, these deep valley dissections are the most striking and admirable topographic features in the area and present, as a backdrop for the project area, a scenic view of considerable rugged interest and visual charm. Up the Allegheny River for 55 miles the visual contrasts are of meanders through a deep gorge, around bends and sharp curves, emerging above this into a broader valley dotted with many islands and river scenery of unsurpassed beauty; and up the Clarion River for another 75 miles to Ridgway the line of sight embraces a reversal of these scenic assets by first furnishing to the educated vision the broad upper plateau areas of the lower river, where the main water expanse of the St. Petersburg Reservoir project would be sited. Then occurs the contraction above this merging into the rivers meanders through which by its cutting and geologic structure it has carved out the most striking of the river's scenic features. Nestled into this

narrow defile, the Piney Hydroelectric Power project hardly does justice to the recreational assets of the valley which a water area should engender. This overall view reveals a major nature area extending from shoreline to skyline along both rivers in one vast spectacle of forested mountain and river scenic panorama, to which is appended as a triumvirate member a continuation downstream along the Allegheny River, to the tremendous horseshoe of the Allegheny River at Bradys Bend.

The St. Petersburg project area is enveloped to the north and east between the Allegheny and the Clarion Rivers in a wilderness rampart preserved in the main as a highly scenic region by the large tract of the Allegheny National Forest and the smaller tracts of state owned park, forest and game lands. These areas occupy most of the Clarion River banks above Cooksburg in a setting which in its present state of development could well qualify for designation as a scenic river.

Exposed rock formations are not too evident along the Clarion River, although the archaeologically important aspect of the entire Clarion River valley lies in the presence of large numbers of rock ledges and out-croppings of sandstones which have weathered at different rates to form rock shelters. Many of these show distinct evidence of prehistoric occupations, often resulting in accumulations of cultural debris of up to 2-3 feet and going back in time several thousand years. Since these rock shelters are often relatively dry due to their protected locations, they contain cultural materials of a highly perishable nature. A majority of these are probably in private ownership. Preservation of these selected sites and their systematic survey and careful excavation may produce valuable information on prehistoric ecology. Besides these temporary habitation sites, the upper river valley contains numerous open-air sites on the alluvial flats. In fact, virtually every piece of level ground along the banks of the Clarion River has been occupied at one time or another by prehistoric Indians. Prehistoric petroglyph (rock engraving) sites in the river valley undoubtedly exist. Along the rim of the valley, are likely habitation sites from the time of the Wisconsin glaciation, about 10,000 years ago. These are hidden in the heavy forestation of the upland plateau in the area from Cooksburg to Ridgway, although such prehistoric camp sites are known from the lower Clarion River. Piney Reservoir, however, has previously inundated some of these sites.

Where not under active cultivation, the project area is covered by mixed forest and scrub, most of it secondary and tertiary growth. There is an absence of agricultural activities in most of the valley above Cooksburg. Much of the valley slope is covered with mountain laurel and rhododendron. No stands of virgin timber are located in the proposed impoundment area. The lower river valley in the impoundment areas as a whole is a pleasant land of intermixed contour-tilled farms, woodlands, scattered small communities, attractive streams in wooded

valleys, and coal lands in various stages of strip mining and of restoration to other uses. Unfortunately, in this area, land reclamation has left ugly scars, and abandoned oil and gas wells and coal mines have burdened the environment with the problem of acid drainage. As a consequence of the natural resource wealth having been concentrated in the reservoir project area, the bulk of the land is privately owned except for some small tracts of forest and game lands of the Commonwealth of Pennsylvania. Above the reservoir area, most of the land is heavily wooded, and there is some plateau agriculture. In the lower elevations of the upper valley between Cooksburg and Ridgway, mostly on the north bank, there are many private camps and summer dwellings devoted to recreation in an accessible river-edge sylvan environment. Above Clarington on the north bank, access along the river is meager, and from Clarion upstream along the south bank to Ridgway, access is practically nonexistant.

Although virgin timber stands only at Cooks Forest, both slopes of the valley and its tributaries are covered with dense vegetation, including laurel and rhododendron, and dense woods. Some tracts of land along the south bank of the river in the scenic river reach above Cooksburg are in private ownership being held undeveloped by timber and gas and oil interests. However, the entire river valley seems to be a part of the winter range of plentiful whitetail deer in the areas where the slopes are covered with laurel and rhododendron, providing cover as well as winter browsing. Black bear seem to be still native in most of the more secluded portions of the river valley. Bobcat population is uncertain. Raccoon and opossum are plentiful, and the red fox is present, but not plentiful. Turkey buzzards have been observed, but knowledge of nesting pairs is not available. Wildlife management is under the observation and care of the U. S. Forest Service and the Pennsylvania Game Commission.

Clarion River fishery resources in the proposed impoundment area are insignificant because of the severe acid drainage situation from polluted tributaries. Unpolluted tributaries are stocked with trout in early spring and provide some fishing for a short period. Fishery resources in the river between Cooksburg and Ridgway are of low value for the same reason. Fish associations are characterized by few species but large numbers of individuals in the region of worst pollution. The distribution of fish tends to remain relatively uniform from year to year. It is expected that in the impoundment area, with improved water quality, fish production should be fairly high: bass, pike, muskellunge and possibly walleyes. The Pennsylvania Fish Commission will determine the need and feasibility of fish stocking in the reservoir area and in reclaimed tributary areas, and future commercial fish potential of the reservoir. An FWPCA benthic biology study of the Clarion River Basin established a baseline of present conditions which can be compared to future, more intensive biological studies. Observations of benthic fauna indicated generally an environmental disruption from pollution. A cursory examination of fish population in the project

area and in the upstream scenic river area to Ridgway reported in Appendix G was made by the Bureau of Sports Fisheries and Wildlife. Previous studies were made by Clarion State College and the Pymatuning Laboratory of the University of Pittsburgh. More currently, Clarion State College has completed investigations on Toms Run in Cook Forest State Park, and has initiated studies in the impoundment area relative to fish population and a scientific approach to fishery improvements. In view of the acid drainage situation, this will include an investigation into the effects of iron on stream biota. Extensive observations on water quality and on a program to minimize risks of major environmental alterations in the impoundment area have been made also by Clarion State College. An abbreviated set of conclusions concerning effects on biota was drawn from these initial studies to the effect that if pollution is abated: (1) In the reservoir proper, primary production will be primarily planktonic. Due to the basin morphology, benthic consumer production may be considerable (based on planktonic primary producers). This will depend, however, on the chemical conditions that develop in the lower water layers in the summer; (2) Fish production should be fairly high. Bass, pike, muskellunge, and again depending on chemical and thermal relations, walleyes may be expected. The population levels, and, indeed, their presence, will depend on suitable spawning sites for fishes of the pike and bass families, provided the water levels are maintained through the spawning periods. The drawdown patterns will greatly affect fish population maintenance.

It is obvious that a pollution abatement program as an environmental feature for the Clarion River Basin is necessary with or without introduction of the impoundment of the St. Petersburg Reservoir project. In evaluating the prospects for economic and recreational development needs as related to completion of Interstate 80, it was noted by the Office of Planning and Research, ARA, that progress in water pollution control will have a bearing on the attractiveness of the area to industries and tourists, both. This program is contemplated under Pennsylvania's ten year mine drainage pollution abatement program. In relation to this program, the likelihood of an impoundment, and the possibility of designation for potential addition of the river to the national wild and scenic rivers sytem, the Commonwealth views these as coordinative possibilities with the Federal Government. The Commonwealth supports the concept that the multiple-purpose reservoir project in addition to user benefits, will provide expansion benefits such as industrial development which will create jobs and a return for investors, and employment in recreational oriented or supporting-type services. On this basis, adequate pollution abatement becomes central to the entire concept, so that the most advantageous extent of development can be realized.

Considerations of present water quality have been made by FWPCA and the Commonwealth and by Clarion State College. A few observations

from each are relevant to the environmental situation. As noted previously in this report chapter, the joint inventory study by FWPCA and the Commonwealth arrived at agreement on the extent of the problem, but not on the degree to which acid drainage pollution abatement should be carried, and consequently a disagreement on cost. The cost analysis made herein in Section IV is relevant to the optimum developmental program associated with the reservoir project. Clarion State College reports from its studies that based on the assumption of pollution abatement to the extent suggested by the FWPCA report, and provided that no unknown pollutants are present in the Clarion River in significant amounts, the following examples of retention effects on water quality in the impoundment may be expected: (1) Surface water temperatures will increase; however, if release of the impounded waters is made at several levels and if provisions are made for mixing (simultaneously drawing from several levels) this temperature-based mixing could have a beneficial effect on Allegheny River water quality; (2) The colder, lower layer of water during summer thermal stratification will probably show a relatively low pH even with pollution abatement. The waters on this area are not highly buffered. Hence, the decomposition of organic materials, along with the residual in the present reservoir, will keep the pH low. Associated with this lower layer, we may also expect reduced dissolved oxygen and slightly elevated iron, sulfates, etc., due to the density of the incoming waters and their subsequent stratification and to increased solubility of the metallics at lower pH levels; (3) the warmer, upper layer (down to say, 5 meters) should remain relatively clean and on the alkaline side of neutrality. Dissolved oxygen will remain fairly high provided temperatures do not exceed, say, 25 degrees C; (4) Spring and fall turnovers are to be expected. During this time, the quality of the surface waters will be reduced by uniform mixing of the reservoir. Provided an abatement program is successful, this will not be severe enough to seriously affect the biota; (5) Due to the size and morphology of the basin, winter-kill of fishes should not occur.

The Clarion State College study reveals also that with respect to water quality endeavors there is essentially little known about: (1) Patterns of pollution loads with respect to stream discharge and other hydrologic factors, such as runoff and relative ground-water contributions; (2) Possible presence of unusual pollutants such as heavy metal ions, other than iron, (Very slight concentrations of these materials can have a disastrous effect on the biota); (3) Levels of pesticide residues, (Influence of these may be considerable and could have a significant impact on the development of a reservoir biota); (4) Present productivity of river waters from a biological standpoint, (Only qualitative data are available on organisms inhabiting the Clarion River, and these are extremely limited. In the unpolluted state, the river waters probably would not be highly productive due to the nature of the geology of the region. However, a trout stream regime is expected under natural conditions); and (5) The early phases of adjustment of a biota to a newly filled major reservoir.

In a general sense, it is concluded that it is possible to reclaim mined areas and improve water quality by the compromise FWPCA - Pennsylvania plan. In addition, effects of domestic pollution must also be eliminated to remove excessive nutrients. On this score, some fertilization of the reservoir can be expected from the inflow. This will increase over time with increasing human population. However, due to the essentially low productivity of local Clarion River waters in the unmodified state, a moderate amount of fertilization may be beneficial in terms of overall fish population. This increasing eutrophic state will inhibit the development of large trout populations, but the moderately warm-water regime may be expected. Unmodified headwater tributaries should maintain brook trout populations and, if free of mine drainage, some of the larger trout tributaries could be managed for brown and rainbow trout.

In the comprehensive sense of multiple-use of the river valley from Ridgway to its mouth, with pollution abatement, the section of the river above Cooksburg could be maintained as a scenic river, and the project area could be developed by means of the reservoir and attendant recreational and economic development advantages.

Timber resources of the project area at this time are mainly aesthetic rather than economic. The more common hardwoods of secondary and tertiary growth cover the forest slopes, except for the virgin stands of hemlock and pine at Cook Forest. Some of this growth occurs along the river edge above Cooksburg. The all-year view of the forested areas is impressive, the evergreens retaining the basic coloration with the seasonal variations in the spring and fall seasons enheightening the visual landscape effects. The fall foliage scene in the Clarion River Basin against the canyon walls is an adventure in visual excitement. Lands within the Allegheny National Forest and the State Forests are managed under the multiple-use concept. Twenty-five percent of the proceeds from National Forest Lands are returned to the counties in lieu of taxes.

Some mention has already been made of archaeological features of the project and the scenic river areas. In addition to the archaeological resources, the historical and natural history aspects of these areas are also the subject of evaluation by the National Park Service. The report, field work and laboratory work were performed at the Archaeological Laboratory of Clarion State College. Historic sites were located, such as old furnaces, mills, etc., and sites of old furnace slag piles and chert pebble locations were field located and reviewed to determine locations of raw material in aboriginal times. The presence of slag was used as an indication of the position of old furnaces. Definitely identified sites, both prehistoric and historic, including remnants of pioneer industries have been reviewed. Artifacts recovered in the survey are on deposit at Clarion State College. Local collectors have partial collections which should be acquired and an exhibition/museum structure should be considered in the recreation and development plan discussed

below as part of the recreational planning for the reservoir area. Artifacts and historical information could be utilized as part of conservation education to relate the prehistory and history of the area. Buchanan Furnace and Eagle Furnace, */ two surviving early iron furnaces within the impoundment area, should be salvaged and moved into the educational and cultural center. The sites of Madison Furnace and Prospect Furnace should be probed for additional information and/or artifacts of the early iron industry in western Pennsylvania. The prehistoric period documentation reveals evidence of early and late woodland and contact periods of occupation of the river valley. There is evidence also that earliest occupation follows from the Palaeo-Amerind Period, the Archaic Period, the Woodland Period into the more recent Historic and Pioneer Periods. It has been established that there are sufficient prehistoric and historic archaeological resources to merit further study and field excavation and location in the impoundment area prior to flooding. Inaccessibility of much of the Clarion River above the project area to Ridgway has not permitted a systematic archaeological survey. Occupation of the valley in this reach of the river is deduced from the pattern of the lower river in the impoundment area and in other areas tributary to the Allegheny River indicating prehistoric human occupation during the Wisconsin glaciation period, the subsequent Archaic stage and during the Woodland stages after the introduction of agriculture (maize horticulture). The extent and temporal affiliation of prehistoric villages on the alluvial flats which were cleared and cultivated along the river by prehistoric villagers would be of interest to the scenic river designation. Historically, the Clarion River must have served as an artery of dispersal of European trade goods from the Atlantic coast into the interior. Mined iron deposits in the Vanport limestone, mostly siderite, was used in conjunction with charcoal, as the principal fuel, in the production of iron in an era of extensive mining and furnace activity. Preservation and interpretation of archaeological and historical material is warranted.

Present Developmental Opportunities

The river area is largely a contrast of a preponderance of forest lands, diminishing agricultural pursuits and oil and gas exploitation, coal mining and partially restored mined-out lands, striking natural scenery and other environmental features which at the present time support development and recreation in more or less isolated patches in the river reach to the Ridgway vicinity. Development at Clarion, Pennsylvania, in the project area is oriented mainly to the educational assets of Clarion State College and a small nucleus of industrial and commercial firms.

Foxburg, at the river mouth, is the location of Foxview, the oldest operating golf course in the United States. Foxview fronts on both the Clarion and Allegheny Rivers on a high plateau. It is and will be primarily a golf center, planned for high quality living with recreational facilities to support and supplement the unique golf facilities in addition to the exclusive living concept. The Allegheny River, at the Clarion River mouth, presently supports boating and pontoon

*/ National Registry of Historic Sites

equipped planes. There is an interchange to Interstate 80 about 3 miles away.

Piney Reservoir offers limited water based recreation due to the steep-sided valley up to the vicinity of Clarion, Pennsylvania. Except for small areas of state owned forest and game land in the vicinity of the impoundment area, there is only an inaccessible reach of the river up to Cooksburg, and Cook Forest State Park. The latter area has an annual visitation of about 1.0 million which overtaxes its facilities and has garish future prospects of overcrowding its virgin tree area and its camping, boating and fishing facilities. A redeployment of its small camping and nature-life areas and reappraisal of its outdoor recreation objectives will be necessary to permit a natural recovery. Clear Creek State Park, upstream, has fewer facilities and less access.

In the river reach above Cooksburg, there are about 111,000 acres of public hunting land. Of this total, 49 percent are state-owned game lands; 8 percent are in state forests; and 43 percent are in the Allegheny National Forest. Summer homes and camps are located along the river, particularly in the Cooksburg - Cook Forest State Park area and upstream. There is access to this area and on upstream to Clarington, a very old town, which could be developed to support the recreational potential of the scenic river reach between Cooksburg and Ridgway. Several of the main tributaries in this reach, such as East Branch Millstone Creek, Spring Creek, Bear Creek, and Big Mill Creek, are stocked with trout and receive moderate to heavy fishing use. Fisherman use of the Clarion River in this 40-mile stretch is low due to acid drainage and industrial pollution. The Bureau of Sports Fisheries and Wildlife, estimates that the total fisherman-use of the four tributaries, is 600 man-days annually and of the river is 800 man-days. Annual use of the public hunting areas is estimated at 8,000 man-days of big-game hunting and 29,000 man-days of small-game hunting. Waterfowl hunting along the Clarion River is performed by "jump shooting" or drifting the river by boat. The segments of the river near Hallton and Arroyo are popular waterfowl shooting areas. Estimated waterfowl hunting use is 100 man-days per season. The Bureau indicates that if water quality is improved to the extent that game fish can be introduced and subsequent natural reproduction occurs, fishing pressure in this segment of the Clarion River would be greatly increased. Access would also play an important role in the future fishery of the river. Parking and boat launching facilities, portage trails and other facilities, would be needed to improve the total recreation planning for the project and associated scenic river area. Activity day use of the summer home and private recreation areas has not been evaluated.

The Allegheny National Forest area enhances the Allegheny Plateau on the north bank of the river from Clarington to Ridgway. Kittanning State Forest and Cook Forest State Park adjoin the National Forest at Clarington. Camping, picnicking and hiking facilities, and artificial

lakes for fishing, boating and swimming are provided, particularly at the Loleta, Kelly Pines, Hill Farm and Bear Creek units. The Hi-La fish rearing pool is located in this vicinity of the Forest. Cook, Zimmerman Hill, Hays and Round Top Fire Tower Lookouts, are located along the river above the project area. There are no winter sports areas in this vicinity of the river. State game lands and state forest lands are located on both banks of the river, interspersed on the south river bank with private holdings, some of large extent: by timber, and oil and gas interests. Access along the river north bank continues from Clarington to Hallton, then leaves the river bank through the Forest area to Ridgway. There is brief south bank access at Clear Creek State Park and the Kittanning State Forest area and none again until Portland Mills. The Penn-Central Railroad follows the north bank downstream from Ridgway, crosses the Clarion River above Portland Mills and heads south toward DuBois. Other state forest and state game lands are located at and above Ridgway. Visitation to the National Forest and state recreation areas has not been totally evaluated. Scenery in this area is outstanding yearlong, but particularly in the autumn and Indian summer when hardwoods present a scintillating display of colors.

Optimum Development

The northern plateau core of the Appalachian Highlands Recreation Study Area is centered on the Kinzua Dam, Allegheny Reservoir, and Allegheny National Forest. Relevance of the St. Petersburg Reservoir to this recreation study area has been discussed previously. The project would serve as a nucleus to which would be added the wild and scenic river resources to revitalize the entire conservation, recreation and development program for the entire Clarion River Valley. The formulated reservoir project, with the recreation, hydroelectric power, and scenic river, and economic development plans presented below, represents a unique combination of developmental units for which there is the necessary open space, recreation and economic market areas, existing and prospective transportation capabilities, water and environmental resources, and requisite cooperation for comprehensive development.

Recreation Unit

The extent of the recreation market area and the evaluation of the gross demand through year 2020 are summarized in Section II from Appendix F, Recreation and Aesthetics. Briefly, the market areas comprise eight counties within a 40-mile radius of the project area within which the population represents 60 percent of the total effective recreating population, and to which has been added an appropriate population segment of the standard metropolitan statistical areas within both the 40-mile radius and a total 125-mile radius. The latter amounts to 30 percent of the estimate. Combined with an additional 10 percent expected to originate outside of this designated market area, the total amounts to 1.3 million recreation participating people. This is expected to increase about 60 percent by the year 2000, probably in the

Pittsburgh Metropolitan area.

According to BOR: Presently there are about 14,000 acres of impounded water suitable for boating and other water-dependent activities available for public use. The Allegheny River, between East Brady and Pittsburgh, Lake Shenango, and Crooked Creek Reservoir, account for the largest acreage. Moreover, there are some 238,552 acres of land developed for various outdoor recreation facilities. Outdoor recreation facilities and opportunities within the recreation market area are estimated to support the following annual activity days: boating, 177,000; swimming, 1,254,500; picnicking, 873, 200; and camping, 172,600 for a total of 2,477,300 annual activity days.

The project area, defined as the Clarion River corridor from Cooksburg, Pennsylvania, to the Allegheny River, presently provides recreation opportunity. Canoeing is the principal activity on the river between Cooksburg and Mill Creek. Although the Clarion River is not generally regarded as a prized white-water canoeing stream, it possesses certain amenities inviting cruise canoeing and camping. It is a scenic water course, with most of its length passing through high, forested hills. It is estimated that the Clarion River corridor presently provides 100,000 recreation days annually. BOR concluded from its analysis of recreation needs for Sub-region F (Appendix F, page F-122) that: (1) there is a need for water-dependent and water-enhanced outdoor recreation opportunities in the sub-region; (2) St. Petersburg Reservoir can help satisfy these needs through the provision of facilities for boating, swimming, camping, picknicking, sightseeing and hiking.

These prosaic conclusions from the view of the usual in general outdoor recreation development are addressed in a somewhat different manner by the Appalachian Highlands Recreation Study,*/ whereby it is considered that: (1) this reservoir as part of a larger recreational complex would offer another public facility that would act as a magnet to attract large volumes of recreationists, and vacationers, with the possible feasibility of year-round vacation recreation as an objective; and (2) very intensive development at Kinzua and the Allegheny National Forest require that the State parks and other Corps of Engineers reservoirs surrounding the Forest (and private developments) should assume a role as focal points for the intensive type recreation, lodges, resort hotels, convention centers, etc. This latter concept would permit vacationers at St. Petersburg for example, to spend several days in the Forest wilderness camping, bird watching, canoeing, etc. However, this study also contemplates St. Petersburg Reservoir area as a singular recreational development in relation to Interstate 80, as an overnight stop for travellers, with lodges, cabins, and motels, as well as camping areas; and additionally to meeting such needs for the transient public, these facilities could also serve as focal points for vacationists if

*/ Continuing study.

major recreational opportunities would also be provided, whereby a marina, golf course, etc., could be used by the transient traveller as well as the longer-stay vacationist.

A third, and probably more comprehensive approach to the potential general outdoor recreation role of the St. Petersburg Reservoir is installation of a recreation unit as part of a broader multiple-purpose economic development opportunity using its scenic and recreational resource advantages in concert with other programs to encourage overall developments of much larger magnitude. Consideration of the Clarion River from its mouth to Ridgway as a possible designee for inclusion in the national wild and scenic rivers system attests to this more comprehensive alternative. BOR considers this in a minimal way by stating in Appendix F, page F-124, that "the scenic qualities of much of the Clarion River valley, together with the existing use of the river by canoeists and boaters, have generated a significant interest in further studies to determine if all or portions of this stream should be preserved in a free-flow state. In view of this, it would seem inappropriate to proceed with the St. Petersburg project prior to the completion of such studies and consideration of alternatives." The reference to scenic qualities in this statement is significiant, in that this is the area's important virtue; however, the best that the recognized intrepid canoeing fraternity can attribute to the river, is that only the tyro in this rather titallating sport would be interested in the Clarion River, and only in a rather restricted reach from the head of existing Piney Reservoir to Cook Forest State Park. Consequently, with the present prospect that the land areas along the river in the project area in their partially restored condition and adding tons of acid drainage to the river will add little to the future economy of the area, this has been alluded to by researchers at Clarion State College and others in the Clarion River Organization for Water Development (CROWD). "This region is the very center of the largest economic market in the world--not like a hub of a wheel, but more like the hole in a doughnut".

Scale of Recreational Development

The need, therefore, in relation to the extent and the quality of the scenic and multiple-purpose uses of this potential project is to optimize the recreational (and other developmental) possibilities in order to capitalize fully on all of the opportunities suggested by the BOR and Appalachian Highlands (ARC) Recreation Studies. It is conceivable that an organizational unit of Government and private interests, probably under State and local initiative, and financing from various sectors could provide a controlled and time-phased repayment plan to effect in the project area the amenity recreational features described below as a nucleous toward plugging the hole in the doughnut with economic returns. On this basis, the BOR recreational plan can be used herein as a framework for a more intensive master plan. Designation of the Clarion River to Ridgway as a whole or in part as an

addition to the national scenic river system and coordination of the project area and of all Commonwealth of Pennsylvania holdings into a gigantic state park would enhance the entire effort. In essence, it is envisioned that this picturesque river area would be in total concept a domain not only for campers and rugged outdoorsmen, but in the larger sense would be also a resort-style state park-type area with the recreation unit below as a contribution to family recreation, as an executive and cultural retreat, and as a possible housing area for persons displaced by the project (see unallocated land area).

General recreation

The framework recreation plan for the St. Petersburg site was designed to alleviate as much of the unfulfilled recreation demand of the region as possible and also to do as much as possible to provide an inducement for economic growth in the region.

The proximity of the proposed St. Petersburg Reservoir to Interstate Highways 79 and 80, to the proposed Allegheny Valley Expressway, and to the Pittsburgh SMSA, is especially advantageous to an extensive recreation development. The recreation development of St. Petersburg can accomplish three things. Planned in an effort to maximize land-use development for many purposes, it can partially offset the high recreation needs of the sub-region. Secondly, it can provide both seasonal and permanent employment for people within the sub-region. Finally, it can provide a more attractive environment, an important feature when the immigration of industry and allied services is desired.

Ultimate recreational development of the St. Petersburg project has been envisioned as a multi-seasonal recreation complex encompassing the four water-based recreational activities of boating, swimming, camping, and picnicking. Additional opportunities discussed for individual recreation sites below would be provided for such general outdoor related recreation activities as golfing, hiking, horseback riding, performance of drama and concerts, snow-skiing and ice skating. Planned and developed with full cooperation from Federal, state and local interests, it is felt that the St. Petersburg Dam and Reservoir would become a major nucleus for economic expansion in northwestern Pennsylvania.

Combined with potential industrial, educational and residential development on open space available for these uses, implementation of the potential framework recreation plan would create a multi-seasonal use area that would add to the totality of opportunities provided by the resources of the region and at the same time would preserve or enhance the already present natural character.

The plan, proposed as a framework at the present time, would provide for the opportunity of utilizing mineral resources within the project area. Seemingly incompatible with recreation activity, surface mining for coal and gas and oil extraction could be conducted in a

general recreation environment, providing the industry and non-Federal Government agencies develop and adhere to a land-use plan and restoration program aimed at creating and/or preserving the natural character of the landscape, essential for an outdoor recreation environment.

A cultural and educational development, such as the Mt. Airy Natural Science Demonstration Area, which is included as part of the potential recreation development plan, would provide opportunities for mineral resource extraction and applied research as well as a scientific and conservation educational program for visitors and students.

The maximum recreation development of the St. Petersburg Reservoir and surrounding lands, as exhibited and developed from both the private and public sectors of the economy, ranges from high intensity to low intensity development. The high intensity, user-oriented area would include an overnight accommodation complex serviced by a variety of recreation facilities associated with year-round resort-type activities.

The medium intensity, combined user-resource oriented areas offer general outdoor recreation opportunity for both families and groups.

The low intensity, resource oriented areas provide opportunities for cultural and aesthetic appreciation, natural history interpretation and semiprimitive outdoor experience.

A potential plan for general recreation development associated with the St. Petersburg Reservoir outlines the scope, size and location of the various activity areas as envisioned generally by the Bureau of Outdoor Recreation. The total annual recreation days for the St. Petersburg Reservoir based on the outlined potential plan are estimated to be 3,360,000 by BOR. It is believed that this evaluation would be exceeded in view of the broader project concept discussed above. The plan of general recreation which follows has been conceived as a framework adaptable to the project as a singular effort, but more effectively would be the basis for the overall objective of economic development.

Plan

In this environmental context, fitted into some 60,000 acres of total project area, this framework general outdoor recreation unit would be composed of some 28,000 acres surrounding the impoundment area and would include as shown a scenic corridor to Cooksburg planned to connect to a potential wild and scenic river designation from there to Ridgway, or to be a part of such designation from the Allegheny River to Ridgway. The impoundment area, the area below the main dam to the river mouth, which includes the reregulation dam and reservoir and the complementary Foxview recreation development and the scenic corridor to Cooksburg is believed to represent a compatible recreational river area within the context of the Wild and Scenic Rivers Act. As indicated before, BOR has developed with the Corps of Engineers this framework plan for general outdoor recreation as a recreation unit of project development which is subject to its current wild and scenic river designation

study of the Clarion River from its mouth to Ridgway. Additional component units to the plan would involve some 10,600 acres for fish and wildlife use in lieu of the area of the project recreation pool.

Siting of the individual areas which are adaptable to various outdoor recreation uses, based on the formulated seasonal pool areas and drawdown regulation, are shown on Figure 11-29. It is expected that in addition to these described below, and the fish and wildlife mitigation lands, the Forest Service and BOR will under the scenic and/or recreational river designation, select and develop with the appropriate agencies of the Commonwealth of Pennsylvania, such other lands as would be necessary to meet their requirements in the project area or in the expanded scenic corridor to Ridgway. Also, that the Commonwealth will participate, as appropriate, in development of the sites for recreation and for fish and wildlife management, education, housing and control of contemporary coal, gas, and oil extraction. The recommendations of the BOM in Appendix I relative to continued mineral extraction is incorporated in the recreation and developmental plan.

Visitation and expected economic impact of the recreational resource 1/ are based upon the mix of unique appeal, attractiveness and location-accessibility. To be competitive with other recreation areas, notwithstanding the large unsatisfied demand, vacationers prefer an area where there are varied activities (multi-seasonal) encompassing both daylight and evening hours. Further, a series of integrated developments is preferable to isolated, widely spread developments. In this context the recreational sites are described below. The acreages cited below include both Federal and non-Federal funds.

Site 1: The St. Petersburg Dam and Reservoir Operation Headquarters

This 100-acre site would provide information and education opportunities dealing with the various engineering aspects of project design and operation. A lunch area, areas for public health and safety, and sightseeing facilities would also be provided.

A highway connection from the Foxburg interchange of Interstate 80 crossing the top of the dam would furnish access to Site 1, adjacent to the left abutment, and to the area of pump-storage upper reservoir and the hydroelectric power plant sites. This combination of siting possibilities of the dam and spillway and hydroelectric power facilities is expected to attract substantial visitation to view the almost 300-feet high concrete structure with steel gated spillway and the related power structures. The natural setting and ease of access

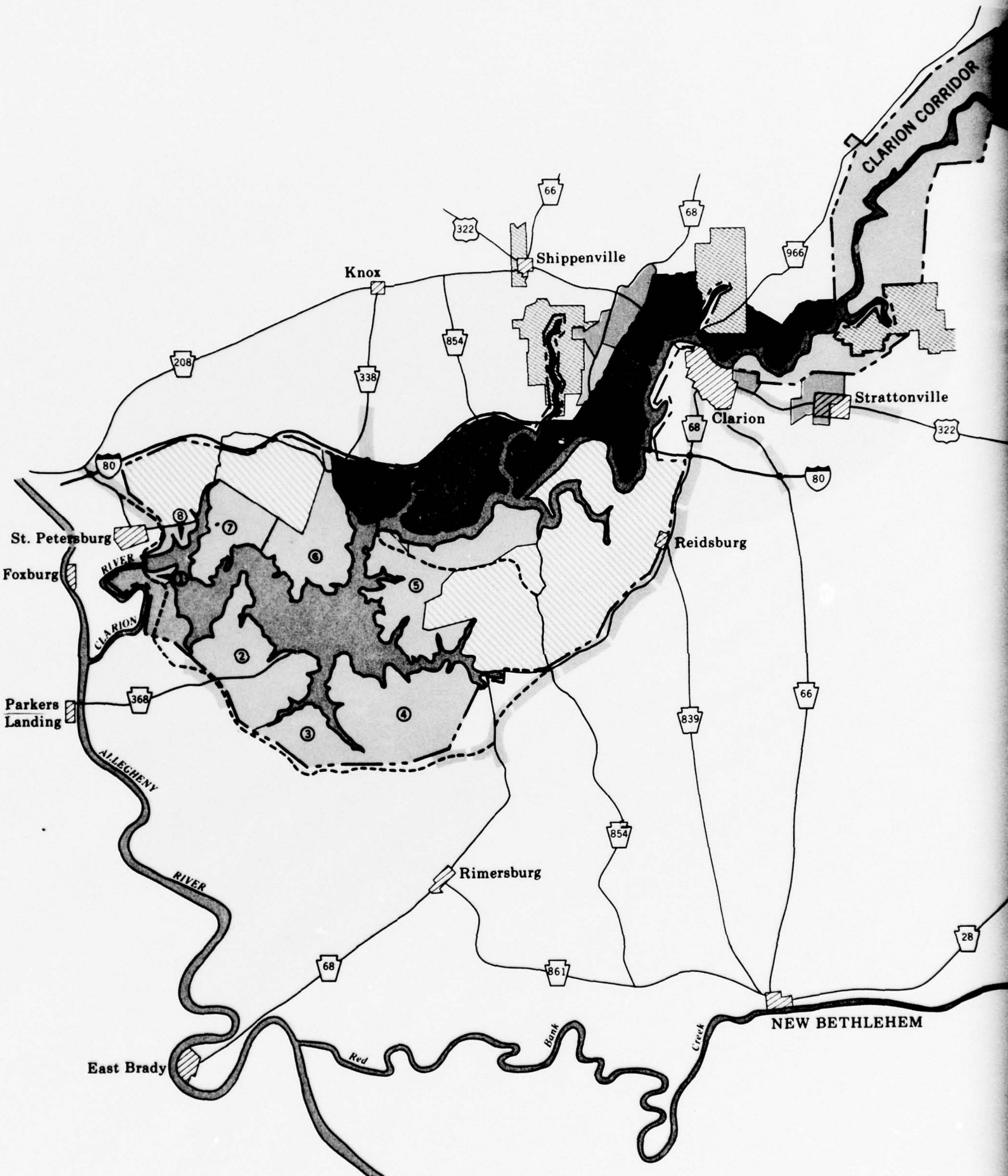
1/ Economic Impact Study, Clarion State College, July 1968.

to this site from a major east-west throughway just 3 miles away with the visual inducements of the structures and the natural scenery would require that creature-comfort areas and facilities in some quantity be planned, plus eating areas and restaurant and sightseeing related facilities. Expectations are that this site would be the most popular attraction in the recreation unit and would be planned primarily to provide visitors with lay information concerning design and operation of the project, and also to furnish information and directions to other sites in the recreation unit. The photogenic properties of this site as an overlook area should be recognized. In connection with the adjacent private Foxview area, coordination of planning would be effective in providing commercial use of their facilities, or of revamping the St. Petersburg Recreation Area (Site 8) on the right abutment area to a more intensive-use site. The areas on the right abutment, composed of the contiguous areas reserved for miscellaneous use and St. Petersburg, Turnip Hole and Turkey Run recreation areas bounded by Interstate 80 and the reservoir, would be used along with Site 1 to furnish resting and additional comfort facilities for visitors stopping only for short periods before returning to travel on I-80. This site overlooks the Foxview private development to the west.

Site 2: The Freedom Resort Area

This 3000-acre site would be a large area adaptable to varied development; surface-mined portions when fully restored for resort-area purposes and natural environment would prospectively be blended in relation to its peninsulas and high promontories as an attractive high intensity use development featuring a complex of overnight facilities, a golf course, and a winter sports area. Restaurants, theaters and shops would augment this nucleus. Satellite recreation opportunities include a riding stable and trails, hiking trails, swimming, and boating opportunities, games and field sports and outdoor amphitheater. Basic recreation facilities intended for use of overnight guests would include golf facilities, amphitheater, and a winter sports area open to the general public. Access would be provided by a new circumferential recreation road. Comfort for the tourist and the vacationer alike, and plushness of accommodations added to the water-based recreation potential and scenic attractions would be the objective of this area. The facilities mentioned are likely to draw the greatest number of visitors, particularly in relation to the nearby urban demand.

There is room in this site for future expansion by private development. Emphasis is placed in this area on the amenities such as the high quality accommodations, fully equipped, and serviced. A variety of family oriented activities would appeal to different age groups and different interests. Access to this area from I-80 and Pennsylvania 68 would tend to cause a divided flow of traffic and to some large extent, avoid congestion and confusion. There would be in


CLARION CORRIDOR
Shippenville
Knox
Strattonville
Clarion
St. Petersburg
Foxburg
Reidsburg
CLARION
RIVER
Parkers
Landing
ALLEGHENY
RIVER
Rimersburg
East Brady
Red
Bank
Creek
NEW BETHLEHEM
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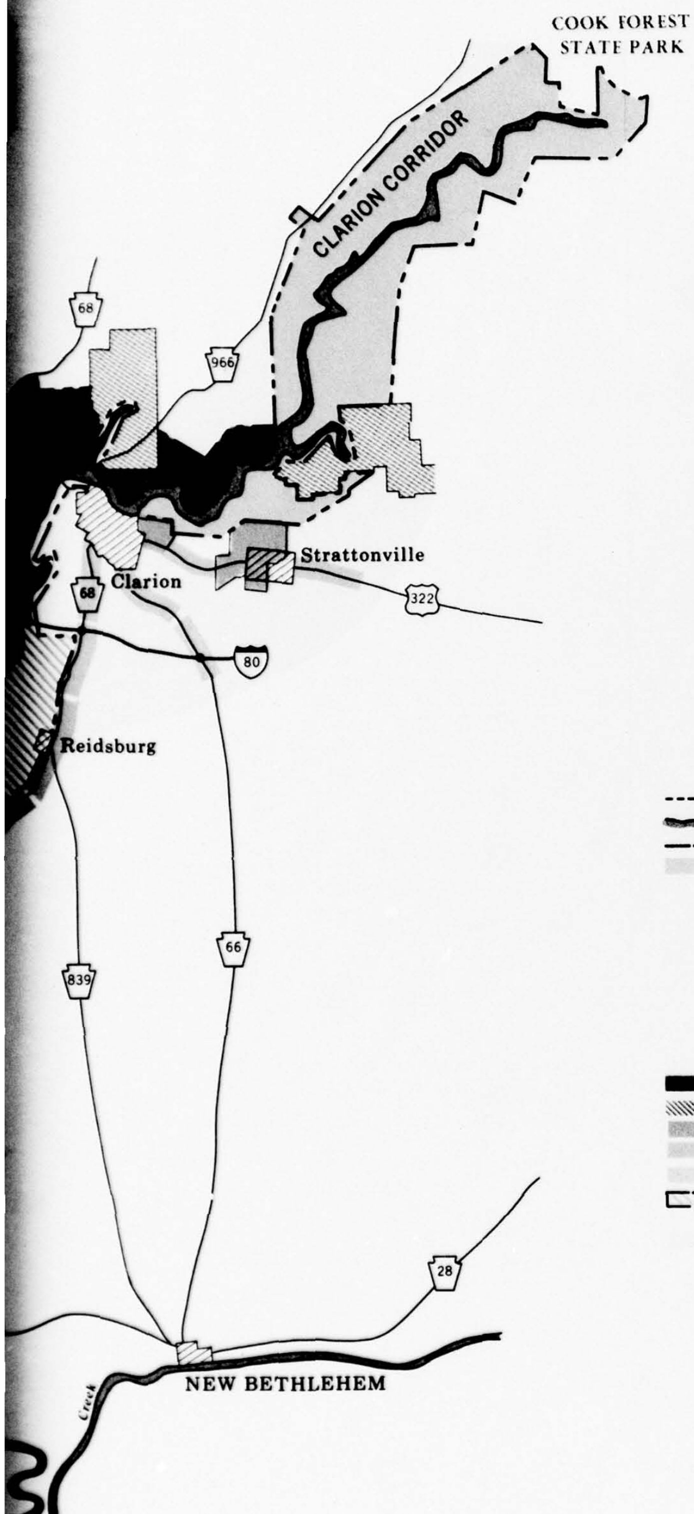

NEW HIGHWAY RELOCATIONS
RESERVOIR FULL EL. 1155.0
POTENTIAL LIMIT OF LAND USE PLAN
RECREATION AREAS
1. DAM & RESERVOIR OPERATIONAL HEADQUARTERS
2. FREEDOM RESORT AREA
3. CHERRY RUN DEVELOPMENT
4. MT. AIRY NATURAL SCIENCE DEMONSTRATION AREA
5. ZION HILL RECREATION AREA
6. TURNIP HOLE CAMPING AREA
7. TURKEY RUN GROUP CAMPING AREA
8. ST. PETERSBURG RECREATION AREA
WILDLIFE MANAGEMENT AREAS
STATE GAME LANDS
POTENTIAL COMMERCIAL SITES
POTENTIAL INDUSTRIAL SITES
RESERVED FOR MISCELLANEOUS USE (Hydropower etc.)
UNALLOCATED POTENTIALLY USABLE FOR INDUSTRIAL, COMMERCIAL OR RESIDENTIAL PURPOSES
POTENTIAL ZONE OF INFLUENCE (Certain Portions To Be Controlled By Planning and/or Zoning)

ST. PETERSBURG RESERVOIR
CLARION RIVER, PENNSYLVANIA

LAND USE MAP

FIGURE 11-29

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this one location, the prospect of finding such varied activities for personal and family enjoyment as would be provided by an 18-hole golf course and a large clubhouse; a large stable with paddock and trails; an 80-unit boatel and accessory marina with slips, services and launches for about 65 boats; games and sports of a more active nature, as tennis, etc; drama and concerts at the amphitheater readily accessible from a 600-unit hotel, a 150-unit motel, and 20-units of rental cabins; a youth hostel to accommodate the wanderlusty in 150-units; and 60,000 sq. ft. of beach area potential for providing swimming privileges to all visitors to the area and would probably be located adjacent to the marina to provide water skiing possibilities also. Complementary facilities would be provided to all of these facilities, such as walkways, and rest areas. Landscaping to suit the mood of this site would enhance the family image which would be presented for the public. For the hardier winter weekend visitors who prefer ice skating and skiing, opportunities would be skating areas and attractive ski slopes from the high promontory levels with lodges of a plushy character for overnight accommodations. There are a number of peninsulas and inlets in this site and varied topography.

Site 3: The Cherry Run Development

This 1500-acre site would be an area set aside for private summer homes, with the land fully restored, controlled by zoning, and guided by a sub-division plan which would insure attractive development Some of the demands of the urban population in the surrounding metropolitan areas within the recreation market area for summer homes that are within easy driving distance of their permanent residence, would be satisfied. A possibility would exist here also for residence at vacation homes for students and educational personnel for Site 4 and Clarion State College. Full vacation home development would be consonant with expected impact 1/ on the project area in that this will be a unique feature of this recreation area which will add stability and quality to it. This type of development also will enhance the economy of the local region by a broader tax base (at the price of tax financed services generally) and from purchase of considerable goods and services locally; thus spreading economic effects over a substantially longer part of the year than the usual benefits from recreation. Urban population attracted by this type of development will also demand more advanced skills and services. Avoidance of conflict between semi-permanent residence and tourist-visitors can be accomplished by reconcilment of interests by public policy and careful planning of the development. The Clarion County Planning Commission has indicated feasibility of such controls.

Site 4: The Mt. Airy Natural Science Demonstration Area

This 3700-acre site would provide opportunity for scientific investigation of surface mining, petroleum extraction methods and

1/ Economic Impact Study, Clarion State College, July 1968

reclamation practices. Based on coordinated interest of private industry, government and educational institutions, the area would provide for ultimate enhanced land-use to evolve from a continuous land-use planning program designed to augment the diversified needs of the region. The area will significantly provide a potential location for a higher education research, training and learning center associated with Clarion State College, and for extension of the Clarion State College Center for Educational Research and Regional Curriculum Development.*/ These and other educational activities backed by Commonwealth participation will expand the educational nucleus already established and will provide increased opportunities dealing with higher education and education of the disadvantaged; possibly vocational training for a more skilled labor force; and further promotion of the flexible all-year school**/ (rotating all-year school pattern) to assure quality education and maintenance of full employment in the force of technological advancement. This against a backdrop of pleasant and attractive surroundings will make the Center more effective by existance of integral as well as nearby (other site) recreational facilities and lands. A conservation learning center which will serve as a prototype for a part of this combined center is presently under construction and development at the Sandy Lake Conservation Learning Center under the administration of Clarion State College and the auspices of the Pennsylvania Department of Public Instruction. Recreation Site 4 will be ideal for multiple-purpose conservation and outdoor recreation education of this kind, and it will be complementary to recreational developments at this project site as related to water and related resources of the impoundment, scenic corridor area (Site 9) and scenic river possibilities (P.L. 90-542), for field trips and workshops in biology and other courses, and an outdoor laboratory for graduate studies, ecological and resource management research, geological research and a base station for research in limnology for the College, and other institutions of higher education, and for research and investigations pertaining to water quality and associated project (reservoir) operations.

Site 5: The Zion Hill Recreation Area

This 4200-acre site would be located on topography suitable for resource-oriented park development. Secluded by physiographic barriers, the development would offer overnight opportunities. Facilities for camping, swimming, boating, picnicking, nature study, hiking and games and field sports would be provided together with visitor education and information center oriented toward the natural science and conservation of the lands and waters of the St. Petersburg Project. This area would furnish an excellent camp for students and visitors to Site 4 for elementary and secondary school programs, with the sixth grade the most commonly served age group. However, civic groups, senior citizens, youth organizations and handicapped groups would also be served in the training programs. The site would accommodate these expectations.

*/ Report, Center for Educational Research and Regional Curriculum Development; Clarion State College, February 1967.

**/ Report, Flexible All-Year School, Clarion State College, June 1967; also Unnovative Developments for Educational Advancement of Society; Clarion State College, July 1967.

Site 6: The Turnip Hole Camping Area

This 1500-acre site would be oriented towards semi-primitive overnight use. Access for public use would be limited to boaters. Facilities would be provided for camping, boating, and swimming. This site is readily accessible from Interstate 80 and Route 68. Fish and wildlife management sites are nearby, and boaters would have access to up-reservoir areas and the Clarion River Natural Corridor (Site 9).

Site 7: The Turkey Run Group Camping Area

This 3,300-acre site would provide opportunity for natural science education in a recreation environment. Facilities for group camping, i.e., adirondack shelters and tenting areas, centered around a lecture and dining facility, would be required to provide lecture and active demonstration projects to acquaint participants with the study of conservation and provide an opportunity to actively engage in its practices. A general recreation environment and facilities for swimming and boating would also be provided.

Site 8: The St. Petersburg Recreation Area

This 300-acre site would be a day-use activity center at the western end of the reservoir which would provide swimming, picnicking, boating and field games and sports primarily for the use of the local communities in the counties adjacent to the project area. Participation of the Commonwealth and the local counties and lesser municipal governmental units in this site would be expected in view of saturation-use of existing facilities at Cook Forest State Park,1/ Piney Reservoir and facilities of the Clarion Area Recreation Board, and similar small recreation areas for day-use purposes. Existing facilities now being renovated and expanded with state funds will only temporarily stem this recreation need. Facilities in this site would include picnic shelters, a swimming beach, a boat launching ramp, facilities for games and participating sports, and sanitation and water supply.

Site 9: The Clarion River Natural Corridor

This 12,000-acre site as an integral feature of the recreation plan would connect the reservoir and Clarion River with existing Cook Forest State Park. Development in this corridor would be kept to a minimum to be compatible with wild and scenic river features upstream. Opportunities for a semi-primitive outdoor experience would be made available in canoeing and boating, camping, natural history interpretation and hiking. This area would be associated with similar activities from Cook Forest State Park to Ridgway. A jeep trail and walking trails would provide the limited access desired. The Corridor is one of the few inaccessible reaches

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1/ Economic Impact Study, Clarion State College, July 1968.

of the Clarion River in a relatively "wild" status. The absence of roads in this reach has protected the archaeologically important assets and probably some of the historic assets from destruction or exploitation. Because of the proposed reservoir, this area will be subjected to the visitation pressure from those seeking the primitive by virtue of access which will be provided by the conservation level of the project. Possibilities in the Corridor of prehistoric camp sites, historical sites, rock shelters and caves, prehistoric petroglyphs, and other natural and scientific assets would dictate that this area be reserved to the project in the full 12,000 acres between the ridges paralleling the river course up to Cook Forest State Park, at least until a full archaeological evaluation is made. As a developmental feature, the project extension to the Cook Forest State Park would be a logical strategy for preservation of these values, preservation of timber and other valuable ecological features, and coordinately to provide the inducement to the Commonwealth to enlarge the State Park concept to the fullest extent to include the reservoir, the present State Park areas, State fish and game and forest holdings and developments, and the recreational and scenic values of the Clarion River from the proposed reservoir to Ridgway.

It is anticipated that the major thrust of private investments within the project recreation complex would be in the Freedom Resort Area, probably to involve all or most of the lodging facilities indicated. Developments of this type by private investments, to be consonant with a coordinated public and private development plan, would be needed before 1990. However, opportunities are not limited to this site for private investment, and areas contiguous to all recreation and fish and wildlife management sites would support a large variety of quality facilities. A large stream of needed goods and services, particularly at high quality developments will promote longer staying times and larger public expenditures which would make private investment experiences more profitable, and visitation would be drawn from greater distances. State and local county participation would be vital to an optimum recreational complex featuring multi-seasonal opportunities, with State guidance and supervision as an integral component of the Pennsylvania Recreation Plan.

Wild and Scenic River Considerations

Correspondence relative to coordinated as well as independent study of the Clarion River from the Allegheny River to Ridgway within the context of the Wild and Scenic River Act, Public Law 90-542, are included in Section VIII, Coordination in Planning. At the time of this writing, the Department of the Interior has initiated field level studies and task-force discussions relating to preparation of its report for the Clarion River, relevant to this report and Public Law 90-542. Guidelines and criteria established by Interior and Agriculture for field use in conducting studies of the rivers designated for potential additions to the national wild and scenic rivers system are being applied to the Clarion River potential. Reasons are stated in the preceding recreation

unit discussion for believing that more than sufficient compatibility exists realistically between potential development of the multiple-purpose St. Petersburg Reservoir Project, in relation to the river's environmental and ecological resources values, developed as either a wild and scenic river, or as a recreation river. Various facets of study can opportunely be considered herein concerning this matter which pertains in outline to: The Wild and Scenic River Act; Activities affecting the Clarion River; Values of Clarion River environmental resources; and needs associated with the environmental and ecological resources of the Clarion River recreation area of influence. In some respects, these facets of the question, which relate to possible conflict of development between use and/or preservation of ecological values, are in the nature of environmental engineering problems which have been analyzed in many comparable and precedent establishing cases, especially, for example, in the Colorado River Basin. The string of impoundments on the Colorado River represents a stepping-stone series of giant reservoirs in which reaches of unmatched scenery and wild and scenic values are interspersed with highly compatible recreation potentials.

The future value of Cook Forest State Park and the balance of the natural ecology of the river is now in prospect of being totally overcrowded in its boat docking areas, fishing and camping areas, and composite recreation areas. The Park is virtually in danger of being walked into the ground. The answer to this problem, and to the balance of the potential wild and scenic river, probably lies in the deployment of similar use areas in the valley, and the siphoning off of the rising visitation to already overtaxed areas of the Clarion River. This could also be accomplished by means of a compatibly developed reservoir impoundment which would be located in the downstream river area where the natural land and water resources are already highly developed for commercial purposes and thereby degraded in its environmental resources, but reestablishable to a relatively high degree within the context of the reservoir development. The question of whether this objective can be accomplished equally or better without such a water and related resource development is treated to some extent below in relation to this study. This will be analyzed further by Interior and Agriculture, and probably by the Commonwealth of Pennsylvania if the desirability becomes apparent of the need for a cooperative agreement between the Commonwealth and the Federal agency that would be charged with administration of the Clarion River as a component of the national wild and scenic rivers system under Section 8 (e) of the Public Law 90-542.

Scenic River Unit

This portion of the project study reflects the value of a scenic river unit of development of the Clarion River from its mouth to Ridgway either integral with the project developmental plan or rated independently as to the following other alternative environmental resources values to which the river could be devoted: (1) Present state of development; (2) Developed as a wild and scenic river; (3) Developed as a recreation river; and (4) Developed as a recreation river by Interior or Agriculture in conjunction with St. Petersburg Reservoir.

Wildlife Considerations

Conservation and development reports prepared for this study by the Bureau of Sport Fisheries and Wildlife explores in some detail the wildlife potential of the Clarion River in the project area to Cooksburg, and of the river and its tributaries extending from Cooksburg to Ridgway. Although it is a popular hunting area, the Clarion River area overall cannot boast of a great profusion of game, but it does provide a reasonable variety of wildlife. The principal game species in the project area, white-tailed deer, cottontail rabbit, squirrel and ruffed grouse, and to a lesser extent raccoon and fox, apparently findive conditions and habitat to suit their unique requirements. The Bureau estimates that 16,300 man-days of hunting occur annually on lands that will be inundated by the project impoundment. Although hunting pressure is considered as generally heavy, particularly during the deer season when there is a large influx of hunters from the Pittsburgh area, the presence of a number of large strip-mined areas which presently are barren and in need of proper reclamation to some extent, indicates a previous habitat loss. The project imposed loss would remove an additional 13,600 acres of habitat at full project impoundment level. At maximum summer level, the habitat area shrinkage would be about 10,140 acres. As compensation for loss of bottomland wildlife habitat which are used for food and shelter by the game noted, the Bureau projects and it is agreed that this loss should be mitigated by furnishing other project lands no less capable of habitat than those which would be water covered or would be otherwise project affected.

It is reported elsewhere, that in the general project area big game hunting is one of the major tourist attractions and is considered excellent as over 1,200 deer and 20 bear are killed annually. Small game hunting is considered to be fair. The economic connection relates to the value of hunting as a revenue producer locally.

As a result of inundation of bottom lands and part of the uplands at the seasonal conservation levels, 16,300 man-days are considered as an annual loss by the Bureau over the life of the project. Accordingly, it recommends that 10,500*/ acres of suitable other land above these levels should be made available in a proposed wildlife management area at a location shown on Figure 11-29. The lands proposed have been jointly considered with the Bureau so that their acquisition would furnish compatablie habitat specifically for hunting opportunities. The area is located on the north side of the river valley contiguous to existing state game lands, and to the project scenic corridor to Cook Forest State Park, where habitat would most nearly approximate the present game habitat. Under the terms of a proposed General Plan for Fish and Wildlife Management these lands would be made available to the Pennsylvania Game Commission. A portion of this land has been previously cultivated and appears highly desirable for habitat.

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*/ See footnote, Page III-11-248.

Timber and browse would be protected in these and in other project area locations which would be selected in cooperation with the Pennsylvania Fish and Game Commissions, BOR, CofE, and the Bureau in preconstruction stage planning. It is proposed also, that selected project lands above the full pool level be licensed to the Pennsylvania Game Commission under the General Plan. As a cooperative measure in the program of strip mine reclamation in the project area, the Game Commission would provide technical assistance to effect the development of wildlife habitat of stripped areas. Waterfowl frequent the Clarion River and adjacent small marsh impoundments, including those in some of the strip mined areas. Township roads presently existing in the project area within the mitigation lands could offer access for game and waterfowl hunters.

In the area upstream from the project scenic corridor, principal wildlife species and waterfowl are those generally found along the Clarion River and vicinity. Public hunting lands in this area proportioned between state-owned game lands (49 percent), state forests (8 percent) and Allegheny National Forest (43 percent) have an annual use which the Bureau estimates at 8,000 man-days of big-game hunting and 29,000 days of small-game hunting. With return of habitat in the project impoundment area, no loss in upper river hunting pressure is expected. Waterfowl-hunting of about 100 man-days annually by jump shooting or drifting the river by boat occurs in and around Halltown and Arroyo. To attract and return waterfowl along the Clarion River in these and other areas it is proposed that food plots should be planted in the flat, fertile lands at the oxbows. Construction of potholes and shallow impoundments on all public hunting lands adjacent to the river should be encouraged also. Strip mine reclamations in the tributary areas would by proper restoration, also add to the wildlife habitat. Sparse access in the scenic river area above Cooksburg to existing hunting lodges and summer vacation cottage areas could be improved.

Allegheny National Forest lands to the north and above the project area in the part which is located along the Clarion River abound in wildlife opportunities. Aside from hunting, many visitors make their nature-seeking hegira to its opulent resources for their therapeutic value and find this by merely camping out and walking in solitude over its miles of shaded woodland trails. The opportunities are there to capture wildlife in the camera lens and to spend a holiday under canvas in an area where many years ago the Indians sought refuge and similar haven in the strongholds of the many rock shelters along the river.

Conservation and outdoor education could be made possible in this scenic to semiprimitive forest area by arrangements with the Pennsylvania Department of Public Instruction under the auspices of Clarion State College. Use of classroom and outdoor experiences could be employed to help young people to understand local, national and world resource-use problems, and to provide a better understanding of the interrelationships fundamental to living things. The objective of the program would be to develop a high sense of individual responsi-

bility to analyze ecological problems and protective or corrective measures relative to their physical and natural environment. Federal program assistance and state assistance could give impetus to this opportunity.

Reservoir and Scenic Corridor Fishery

As before, the Bureau of Sport Fisheries and Wildlife has made an investigation of the details of the fishery aspects of the project impoundment area and of the scenic corridor. Fishery pressure is reported to be about 1,000 man-days annually in the project area, about 600 man-days in the trout stocked tributaries upstream, and 800 man-days annually of fisherman-use in the 40-odd mile stretch of the Clarion River above Cooksburg. These have assumed no spectacular proportions, in fact the present fishery is insignificant, because of stream pollution by acid drainage and industrial wastes. In the upper river area fish species which have survived semi-adverse conditions are stonerollers, minnows, chubs, shiners, brook lampreys, suckers, bullheads, yellow perch, rock bass, smallbouth bass, darters and sculpins. In tributaries like Toms Run, where benthic and chemical conditions formed by acid drainage and oil and gas well pollution are not completely overpowering, recent studies by Clarion State College reveal presence of brook trout and species of fish tolerant of a variety of habitats and physico-chemical conditions, including the white sucker, creek chub, blacknose dace and bluntnose minnow.

The Bureau recognizes that the lower end of the reservoir would be broad and have numerous coves, while the upper part would be narrow and winding. Beyond indicating that the value of the fishery that would develop in the reservoir would largely depend on the success of a mine acid abatement program, no specific information relative to fish habitat, species, stocking, etc., is conveyed. Its report indicates that the project will produce a net gain of about 149,000 man-days of fishing annually.

Included in the Bureau's General Plan for Fish and Wildlife Management for reservoir fishery are stipulations in anticipation that the Pennsylvania Fish Commission would determine and initiate management practices that would be the basis for establishing and maintaining fisheries in the reservoir. Under this arrangement, portions of the reservoir would be managed solely by the Commission under the plan. Some observations relative to productivity of river and reservoir waters made by the Department of Biological Science, Clarion State College, pertain to the state of present knowledge concerning pollution abatement and establishment of river and reservoir fisheries. Biological data are envisioned in two instances, both with and without the project, but with pollution abated. With the project impoundment, and with pollution abatement, factors relevant to retention effects

on water quality are suggest for future consideration in relation to studies of downstream water quality effects and reservoir effects on the biota which are considered basic to production of the best fish population. It is concluded that due to basin morphology, benthic consumer production may be considerable (based on plankton primary producers). The Clarion State College preliminary report qualifies this to the extent that this would depend on chemical conditions that would develop in the lower water layers of the reservoir in summer.

It is anticipated by Clarion State from the data at hand that fish production in the reservoir should be fairly high. Bass, pike, muskellunge and possibly walleyes would be expected to be sustained. Fish population levels and, indeed, their presence, are indicated to depend on suitable spawning sites for fishes of the pike and bass families, provided that reservoir water levels would be maintained through the spawning periods. In this respect, biologically, drawdown patterns would greatly affect fish maintenance.

Facilities suggested by the Bureau, and costs therefore, are considered herein in Section IV. These would involve furnishing adequate fisherman boat access to the reservoir, and requisite parking spaces and launching facilities; and land-based fisherman utilization and access by means of fishing piers adjacent to recreational developments in areas of good fishing habitat. Spawning marshes for esocid fishes should be developed at suitable locations adjacent to the reservoir, to be a major factor which would contribute to establishment and maintenance of reservoir sport fishery. As another part of the fish and wildlife plan, areas of standing timber in the reservoir which could create important habitat for some species of fish, and also could provide good fishing locations, would be selected for reservation by the Fish Commission, the Bureau in cooperation with the CofE. To provide conditions favorable to fishing, it is contemplated that some form of reservoir zoning plan would be desirable, which would be developed cooperatively by all agencies responsible for recreation activities to avoid conflict of use.

Basic to fishery development in the reservoir is, of course, abatement of pollution. Part and parcel of the pollution abatement program is the necessity to also abate pollution above the impoundment area, in fact to Ridgway and the remainder of the Clarion River Basin. A measure of the damage which has been caused to the existing river fishery by pollution in the Clarion River drainage is indicated in Work Document No. 27, Benthic Biology, Allegheny River Basin, New York - Pennsylvania, with respect to bottom-dwelling macroorganisms. In its field and study analyses, responses are shown at individual testing stations of the resistence of the bottom fauna to various intensities and types of pollution, from the Clarion Basin headwaters to its mouth. Adaptations, or eliminations, of various identified

species in relation to their ability to maintain life processes are reflected in the work document concerning the specific responses of these macroorganisms to the degree of survival of the most sensitive ones, and in turn the less sensitive ones. The West Branch of the river apparently has a relatively large number of varieties of species of macroorganisms of the most sensitive tolerance group, indicating relative lack of pollution. Pollution from the East Branch and Elk Creek partially offsets the excellent quality water from West Branch to the extent that even with pollution from Little Toby and Toby Creeks the benthic condition of the river just below Ridgway is such that the more sensitive species exist with a fairly good number of specie varieties downstream through the scenic river reach to the mouth of Mill Creek, below Cooksburg. Development and improvement of a river fishery throughout this reach should be possible with some abatement of pollution. Fishery development in heavily polluted tributaries would require more intensive abatement, which in turn would improve the river fishery potential. Assuming that abatement efforts by the Commonwealth would be exercised in this scenic river reach, fishery potentials of the river and the potential project impoundment take on added value with respect to future recreation visitation. It can be concluded, as does the Bureau that fishing pressure in this segment of the river would greatly increase over its present use.

Benthic conditions below the mouth of Mill Creek to the mouth of the river, in the project impoundment area, reflect the present drastically altered benthos, illustrating a very small number of varities of species tolerant to pollution, and the further and more imperative need for a coordinated state and project associated pollution abatement program, if fisheries are to be developed most proficiently. The Clarion State College investigators, in considering the relative resource merits of the river from the biological standpoint, have embarked on a continuing program of research into the determination of acceptable levels of various pollutants and their effects on the river biota in relation to fish species and the correlative effects of other environmental factors. From their preliminary water quality and ecological analyses they have reached the tentative conclusion that under optimum conditions it would be possible to reclaim mined areas and improve water quality to return fish populations to good diversity and numbers. A further observation concludeable from their study relates to the qualifications of the ecology and environmental resources of the river for inclusion in the national wild and scenic rivers system within the intention of the Wild and Scenic River Act. To this extent, present indications are that the section of the stream above Cooksburg could be maintained as a scenic river and still develop a reservoir with all of its advantages.

The Pennsylvania Department of Health with the cooperation of the Fish Commission and the Bureau would be expected to evaluate, draw up requisite water quality standards conducive to both optimum river and reservoir fisheries, and exercise adequate controls to assure that

abatement and other water quality measures would be effectively carried out and maintained.

Archaeological, Historical and Natural History Interpretation

Full assessment of the archaeological resources of the St. Petersburg project area within the major impoundment reach and the downstream reregulating reservoir reach, and in the scenic river reach, would require a more detailed survey than performed to date. There is little doubt that the archaeological resources of the valley are considerable and that a systematic site survey followed by careful excavation of selected sites would contribute greatly to understanding of the prehistory of the area. At the same time, the Indian rock shelters may produce valuable information on prehistoric ecology and natural history. Clarion State College has supplemented the National Park Service report which was made for this study utilizing college facilities for this purpose. In view of the fact that virtually no extensive and coordinated archaeological work has ever been conducted within the project area or the upstream scenic area, sufficient lead time should be allowed for extensive test excavations and salvage or preservation plans in order to gain a thorough understanding of prehistoric and historic resources. Correlation of archaeological findings with those of the present ecology should be incorporated into the conservation and outdoor education plan suggested above.

Further search and inventorying of sites and artifacts would be needed as well as a search of published and unpublished written sources of information concerning pioneer times in the valley, accidental finds of prehistoric tools, etc., to assure finding, recovering, and preserving prehistoric sites for their contribution to understanding of local history.

Environmental Quality Improvement Potential (Pollution Abatement and Land Reclamation)

Some extensive research has been made into the dual Clarion River Basin pollution and land restoration problems which over a long time period have plagued the valley and hindered its economic and recreational development. At this report date, the acceptable solution of these are considered fundamental with respect to project credibility, and to the projected increase in recreational and economic development opportunities.

As a prelude to the various aspects of project development, a "Report On The Present State of Pollution In The Clarion River" was prepared coordinatively by Curtis Sandage, Ph. D., with the aid and cooperation of the Department of Biological Science, Clarion State

College. The Pennsylvania State Department of Health has monitored water quality in the Clarion River at its water quality network stations 8-21 through 8-25 for the period 1962 to date, data from which were background to the preceding report. The Department has also submitted for consideration relative to water quality both an unpublished memorandum report and another report which was presented in June 1968 at the project public hearing. In addition, it has established a set of water quality criteria for the Clarion River which were aired for public review and consideration by the Commonwealth's Sanitary Water Board at a public hearing in February 1969. An observational report based on the Sandage report and on the FWPCA-Pa. joint acid drainage study in 1968, and other research investigations pertaining to pollution and pollution abatement in the Clarion River by Kenneth J. Linton, Ph. D., with cooperating investigators Bruce H. Dinsmore, Ph. D., and John E. Williams, Ph. D., all of Clarion State College, Department of Biological Science, have been subjects of interest relevant to scientific analysis of the river water in a polluted and in a natural state. Basically it appears that the project must provide an integral program that would return the water quality of the Clarion River to a state compatible with formulated project purposes.

Consequently, on the basis of the above preliminary research work it is believed that a sounder basis would be provided for a meaningful evaluation of a project associated pollution abatement program by continuation of present research efforts. In view of the large amount of acid drainage involved in the environmental problem, such study would be necessary to contribute significantly to an understanding of some of the ecological relationships which operate in the rivers aquatic environment under the influence of acid mine drainage; and also of the possible masking effects of multiple pollution problems in reducing their related apparent severity. Also, in view of the relatively large investments, public and private, which could be made in this project, a number of biological objectives for further research would be further considered necessary in the project preconstruction planning stage. Among other things, there would be a need to develop a research program for the Clarion River in relation to the project to establish the possible presence of unusual pollutants such as heavy metal ions , other than iron; determination of safe levels of iron; presence of pesticide residues; productivity of the presently polluted and also unpolluted river water from a biological standpoint; seasonal and other patterns of pollution loads (such as diurnal patterns in chemistry) with respect to existing standards; comparison of laboratory and actual stream conditions; and investigation of the feasibility of using multivariate analysis in establishing water quality criteria for the river in relation to the project. At present, only scanty data are available on the state of biota of the Clarion River. The study proposed herein would supply some needed basic information and, at the same time, would serve

as a pilot study to explore the possible directions of an expanded research program in the following years, especially in the preconstruction and postconstruction stages. This would provide a sound basis for evaluation of changes in water quality over a period of years. A research proposal concerning this work probably would be solicited from Clarion State College based on continuing experiences and knowledge on the biological and ecological states of the Clarion River.

The preceding factors are relevant to establishing and determining the cost of an effective pollution abatement and land reclamation program herein. Pennsylvania's Supplement to the Main Report, Part VI, contains a cost estimate of $60 million for the total Clarion River Basin mine drainage pollution abatement work. This is derived partially from the Commonwealth's experience with its Moraine State Park abatement work. The total program envisioned by the Commonwealth for complete abatement for the entire Clarion River Basin would consist of items for backfilling 20,000 acres and burial of refuse - $30 million; mine sealing, grouting, surface diversion, etc., - $15 million: and construction of five treatment plants - $15 million. It is not contemplated that this degree of abatement and associated land reclamation would be necessary to achieve project purposes. The Department of Mines and Mineral Industries recommended procedure, in the Clarion River Basin, on a progressive time scale, would probably encompass the following steps to control or eliminate the acid mine drainage pollution:

1. Removal and burial of all mine refuse piles consisting of acid producing materials to the abandoned strip mine areas.

2. Install permanent type grout seals at all deep mine openings with the mine workings to the rise and where major discharges of acid water are emanating.

3. Sealing of mine drifts, slopes and air shafts with clay or other suitable material where the body of the mine workings lie to the dip.

4. Backfill and plant abandoned strip mine areas to alleviate runoff and seepage through spoil areas.

5. Plant grass and/or trees on reclaimed strip mining areas to cut down the excessive turbidity and oxidation.

6. Construct diversion ditches and slope drain flumes to direct surface water around or across affected areas.

7. Evaluate results of abatement program. If acid discharges are still objectionable, additional reclamation measures or treatment plants may be required. With treatment plants, not only is there perpetual maintenance, but lime neutralization yields a highly flocculent hydrate and creates disposal problems.

8. Investigate adequacy of construction measures and perform necessary remedial measures.

These would be based on the preceding suggested research and on an engineering study of the applicable geographic, geologic and mining conditions in the area, methods which would be employed in the investigation and proposed control measures relative to mine drainage. Objectively, this would provide a body of information which would prevent the impoundment area and associated upstream scenic river area from being polluted, with detrimental effects on water-based and water-oriented recreational usage and aquatic life. The above work items have been analyzed with respect to project purposes and costs estimated for applicable items and extent of involvement are contained in Section IV, Table 11-22. Variations from these items would be determined as necessary to proper restoration or reclamation for the recreational unit of the project plan. It is tacitly understood that the $15 million estimate of cost in Table 11-22, would be a Federal expenditure. Costs beyond this estimate relevant to broader state objectives, would be expected to be borne by the Commonwealth.

The above mentioned research reports are on file in the Pittsburgh District Office, C of E. Data relative to Pennsylvania Water Quality Network stations on the Clarion River are on file in the Department of Health, Harrisburg, Pennsylvania. Compilation and analyses of these data are contained as appendices to the Sandage Report. Other reports and field data are on file in the Department of Biological Science, Clarion State College, Clarion, Pennsylvania.

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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)

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Economic Development Potential

In 1964, prior to project consideration, the Federal Area Redevelopment Administration assessed development needs and opportunities for the project area through its field coordinator for Western Pennsylvania and its Office of Planning and Research, Washington, D.C. Observations precedent to the study indicated that unusually severe water pollution problems were handicapping the area in many ways, including adverse effects on industrial and tourism development. An appeal for local community action to alleviate its plight was based mainly upon modern transportation, Interstate 80, and environment restoration to create new opportunities in manufacturing and in tourism-recreation as sources of new jobs and income, and in community improvement and natural resource conservation and development to make the area more attractive as a place to live and work, or to visit for recreation. This concept was reaffirmed and activated by the catalytic action of the project, when in May, 1968, many citizens of diverse backgrounds and interests joined together to form the Clarion River Organization for Water Development (CROWD). Two significant broad purpose objectives motivate this community action by CROWD: achievement of regional reclamation, and regional development. On the first score, CROWD indicates that land and water conservation are of such significance that principles relevant to education of all inhabitants from very young children to senior citizens be broadcast through school programs, community programs and regional efforts. Also, that wild life sanctuaries and natural areas must be included to preserve the great heritage of the region, to which would be applied the important contributions which biological research stations could make if established under governmental and college (Clarion State) sponsorship. Regional enhancement is envisioned by CROWD based upon the potential of the area supplemented by the St. Petersburg reservoir project. Correlation of developments would be expected under which the project's purposes would serve as the bases for development of many recreational and leisure time activities, hydroelectric power, etc., together with the economic benefits which would accompany such development. Conclusions by this organization relate to the potential for industrial and commercial development with related implications for increased employment, higher standards of living and greater personal opportunity. Particular reference is made to the anticipation that the up-river site of the dam and the region surrounding the reservoir would be served in development in a manner which would be unique. In brief, the economic advantages to the region and to downriver areas were cited as being of a high order of economic importance, together with their social consequences. The Commonwealth of Pennsylvania also considers that the St. Petersburg project would have a tremendous effect on the area. Reference is made to a full exposition of the economic development potential presented by the Secretary of Forests and Waters at the project public hearing.

Previous references have been made to the potential for development, among other things, of chemical and other industrial complexes in the area adjacent to the project area, and for tourism-recreation programs. Examinations were made for this study of a wide range of economic responses to which the local area particularly, and to some extent the downstream river areas, could react which may be slowed or fail to be materially realized without the project. An independent economic impact study made by Clarion State College, intended to supplement the study herein, covers the industrial, commercial, recreation, and service sectors of the regional economy. The latter delineates the impact area of the project as an immediate impact area and a broad impact area. These relate to 40 and 125-mile radius zones which are in consonance with the extent of recreational impact areas analyzed by BOR. However, the study is restricted to effects in the area of immediate impact. The study discussed below is on file at Clarion State College and the Pittsburgh Engineer District, C of E.

Population of the eight counties (Mercer, Venango, Forest, Lawrence, Butler, Armstrong and Jefferson) in the immediate area of the St. Petersburg project in 1960, amounted to 5.2% (588,627-people) of the 1960 state population (11,319,366-people) in 9.3% (4,188-sq. mi.) of the total state area (45,007-sq. mi.). The 8-county area is predominantly rural, characterized by rural poverty in the Appalachian mold. There is not a single significant metropolis to which development could be annexed. There has been a constant population decrease, particularly after decline of the extractive industries, bituminous coal and crude petroleum, and phasing out of full-scale agricultural activities. Three counties on the west bordering the Youngstown area have shown slight to substantial population increases in the 1950-60 period while the eastern counties have all lost population. In between these, Armstrong and Clarion Counties adjacent to the Allegheny River have declined moderately.

Extractive industries of the area have declined considerably in their scope and nature, but their contribution to regional income, employment and output is still significantly high. Bituminous coal industry output in Clarion, Armstrong, Jefferson, Butler and Lawrence Counties constitutes about 17 percent of the state's, at a very competitive cost of production of coal at less than 20 cents per million B.T.U.; average ton output of coal per man-day exceeds the state average considerably. Total regional output of crude petroleum has been large, varying between 9% in 1962 and 12.2% in 1965 of total state production. However, the latter was from 31 percent of the state's wells, causing with the coal decline a great deal of structural unemployment.

Regional value addition through manufacturing was about 5.3 percent of the state. Production and other related activities was about 5.6 percent. However, a great industrial imbalance exists, with Butler, Lawrence and Mercer Counties adjacent to Youngstown being more industrialized than Armstrong, Venango, Clarion and Jefferson Counties. This

has been aggravated still further by an imbalance within the industrial structure, being narrowly specialized in a few heavy industries. To illustrate, for 1965, of the five leading industries the following relates to employment:

Industry	% Employment of state total
Stone, coal and glass	20.1
Primary and fabricated metal products	15.2
Petroleum and coal products	12.8
Machinery, except electrical	8.5
Lumber and wood products	8.2

It is noted that while there is a state imbalance as well, it exists to a greater extent in this area, so that the economic implication of this narrow specialization in capital and heavy goods industries is an accelerated impact on their demand due to moderate changes in demand for consumer goods which these capital goods assist in manufacturing. Resultant condition has been to cause regional to natural unemployment rates of about 2:1. Furthermore, these main-stay industries are also declining overall, nationally. Most significantly, manufacturing of consumer goods industries which have a stable demand pattern are either insignificant or absent from the local scene.

Trade and services are significantly underdeveloped. Average retail sales in 1963 comprised only 4.6 percent of the state total: with an insufficiency of retail services in food stores, general merchandising, apparel, eating and drinking places and drug stores. The picture is grim in relation to wholesale trade and services. In 1963, wholesales of the area were only about 1.9 percent of total state, and services were only 2.5 percent of total state receipts. Lower employee earnings in services were comparatively 2 percent of total state payroll for 2.5 percent of total state services. Services were inadequate in almost all respects, but were more particularly lacking in hotels, motels, tourist courts and camps; miscellaneous services and personal services.

Transportation facilities in the area by highway and railroad appear to present no significant problem, although Jefferson, Forest and Venango Counties in 1966 were below the state average of 2.37 miles per square mile. There is no major commercial airport except one at Franklin-Oil City, which in 1965 handled less than 1 percent of the state total. Airmail carried was about 1 percent of the state total, and cargo shipments were 2.2 percent of the state total. Public transportation in the immediate area is very backward; public transportation revenues and number of passengers were less than 1 percent of the state total in 1961. A general aviation airport has been proposed for a site in Clarion County near the project area. 1/

1/ Site Selection Study for Clarion County Airport Authority, Yost Associates Inc. Engineers, April 1968.

The eight-county area offers limited and poor credit facilities. As of December 1965, the regional bank total demand deposits were less than 1.9 percent of the state total and time-savings deposits were barely more than 2.5 percent of the state total. Outstanding credit union loans were about 3.9 percent of state total as of December 1965, with assets less than 5 percent of state total. The Pennsylvania Industrial Development Authority (PIDA) during July 1965 to June 1966, committed only 4.3 percent of state loans, and at the same time tentatively approved 12.9 percent of state loans to the area, for an overall average of 5.6 percent of the state total. In this instance, there is within the area a great disparity in extension of credit, with Forest County receiving no loans, and Clarion, Jefferson and Mercer counties receiving less than the average for the eight-county area.

Prediction of the capacity of the multi-county area to generate income from investments could be generally related to the Robert R. Nathan Associates Recreation Study multipliers, which indicates a leakage in spending and respending of about 50 percent. An average multiplier for the area is about 2.0 and 2.05 for Clarion County. The latter is used in Section V in determining expansion benefits relative to the recreation development unit of the formulated project. Some importance may be attached to the relatively high rate of leakage from the regional income spending stream relevant to the area's development potential, and in many respects these pertain particularly to the prospects of Clarion County to sustain the extent of the reservoir development and the associated economic developments.

Problem Areas

Some factors detrimental to the future economy of the area are reflected in the relatively low-sized multiplier effect. The impact study to date has revealed a number of economic adjustments that would be necessary to mitigate the so-called "hole in the economic doughnut" developmental atmosphere of the area. Opportunities to set the groundwork for forming a more viable economy center around the St. Petersburg Reservoir project as a nucleus. Permanent population exodus and regional unemployment due to structural changes in the manufacturing industry, i.e., automation, upgrading of skill, etc., are linked to the steady outmigration of population. Specialization in a narrow range of declining heavy industries is responsible for big leakage in the income-spending stream due to heavy imports of varied kinds of goods and services from other regions while exports of these specialized industries are gradually declining. This latter pertains also to wholesale and retail trades and services wherein the area is very backward and has experienced constant decline. A permanent deficit on the "balance of trade" of the immediate study area stems from high regional costs of public and private services, distribution channels and transportation facilities due to weak consumer demand and low volume of sales. These factors have rendered the regional output incompetitive or less competitive. Extremely insufficient credit facilities are of immediate concern to any developmental opportunity, particularly in the private

sector. Future leakage due to failure of the area to supply additional demand, and of public or private institutions to furnish credit probably would hamper private investment opportunities from the outset. Beyond the temporary boom stage of employment generated by construction of the potential major water resource development, the economic effect would probably fade away after the last round of multiplier effect has taken place if credit expansion would not be profferred as an essential requirement of sustained regional economic growth. The concept for which an analysis of the area economic needs and potentials follows would be relevant to continuation and expansion of employment opportunities from such a project by providing the means for attracting lucrative investments and rejuvenation and revitalization of the area's private sector. A viable area economy would require reversal of trends now already firmly established away from the area's declining natural resources and manufacturing industries to a more desirable industrial mix, with employment opportunely to be heavily concentrated in rapid growth, high wage-paying manufacturing and non-manufacturing (recreation) industries, probably by some mechanisms of expansion of regional credit facilities and by offering proper tax incentives to such new industries.

It is apparent that the present drastic economic plight of the area, especially as related to the above sources of income-spending leakage, would require rather detailed economic investigation. The economic development situation of the immediate area and the project impact area could be enhanced thereby with respect to reducing the existing leakage rate, which would in turn be expected to increase the size of the multiplier and regional income expansion. The following discussion relates this concept to some prospects for bettering the area's economic position and employing its various developable resources, including the St. Petersburg Reservoir project, for developmental purposes. This suggested study could lend itself also to existing and potential Clarion State College research efforts mentioned previously, which in the overall, has the objective of improvement of economic development potential involving environmental and scientific resources, environmental education, regional economic development, water resources development oriented to water quality and fisheries, and archaelogy and historical resources, etc. - all encompassed in a regional research center. A regional economic development institute could become a part of this research center entrusted with various tasks: study of economic and industrial structure to appraise federal, state and local government units of needs and desirable steps for constructive action, and familiarization of private investors with the area's economic and industrial potential for their benefit and guidance; assistance of member agencies in formulation of proposals for seeking financial and technical assistance from public agencies and organizations; assistance of private investors, outside and inside the area, in preparation of investment proposals by conducting marketing, economic and technical feasibility studies, and, working as a liason between credit agencies and potential investors, to assist in obtaining necessary credit facilities from financial institutions; and promotion of a model industrial city complex around

the project area to include features of an industrial estate on a large scale and to provide guidance relative to community services such as modern housing, shopping centers, schools, vocational training institutes, recreation areas, churches, and other features of contemporary urban life. The latter would be promoted, perhaps somewhat as envisioned below, to attain the economic objectives - presently deficiencies - to correct the present industrial imbalance by attracting modern and growth industries; to create a pool of common research facilities from the research and development resources of each selected industrial sector which could be shared to realize joint economics in their cost of production; to attract to the area regional industrial establishments which need fresh roots, particularly those operating in similarly poor existing environments and with outmoded production facilities; and to blend in the form of a balanced structure, industry, trade and services with a model urban city against a rural background with amenities to improve the quality of life in the region and to create a climate for sustained economic development.

Recreation-tourism potential in the immediate impact area presently appears to suffer from many of the same deficiencies mentioned relative to other types of development. The main assets of the area are the landscape and the limited scenic reaches of the Allegheny and Clarion Rivers. Relatively limited recreation facilities are available, especially when consideration is given to proximity to population centers of Erie, Pittsburgh, Youngstown and Johnstown. The Clarion State study extends this area of influence from a 2-hour driving time to a 6-hour period to illustrate that with the construction of interstates and high speed rail transport, the project area would be subject to recreational pressure from the broader impact area also. In relation to this, there are only a few major facilities within the immediate impact area: Allegheny National Forest, Crooked Creek State Park in Armstrong County, Cook Forest State Park in Clarion and Forest Counties, Clear Creek State Park in Jefferson County, McConnells Mills State Park in Lawrence County, Moraine State Park in Butler County, an unnamed major undeveloped potential state park area in the Allegheny River in Venango County, the Park of the Islands which originates in Forest County and continues northward in the Allegheny River to Warren County, and a number of state forest and game lands. These involve vast areas, but comprise relatively few developed facilities.

Interim Evaluation of Developmental Potential

The foregoing applies to prospects for devising a developmental program by which the project and related resource developments and a set of induced economic activities could be expected to have some significant degree of success in modifying worker and resource unemployment in the immediate economic and scenic areas. There are no guarantees that the above objectives if promoted would produce a more viable economy than presently exists without some form of direction as anticipated by an economic development institute underwritten by Federal and State participation. However, the extent of the problem areas locally in the immediate impact area in relation to the downstream impact

possibilities lends encouragement to the prospects for fuller realization of user benefits by virtue of the water resource development project, with the scenic river innovation as an important additional component, particularly when considering the favorable resources contributions under an improved environmental situation. Not only that, but considering the assets of the area, the possibilities of environmental improvements, and the desire of the Commonwealth and the local governmental units to remove remaining restraints to development, some credibility could be attached to the stimulative potential of the potential reservoir project and the associated scenic river environment if the developmental process would be controlled rationally to realize these potentials by being specifically planned, programmed and managed. Most importantly, explicit recognition of the area's important needs for economic and environmental improvement and a possible process by which this may be achieved is identified as a major stimulus which could bring about water resource development - economic development interactions. To date there has been evaluated preliminarily the uniqueness of the needs of the immediate area's potential water and related resources developments; the research efforts which have been established with the Commonwealth and local development districts associated with the area and which can be facilitated into an action program by the project conception; the evaluations of creative approaches which could be exercised to apply toward marketing of the immediate area's assets for industrial and recreational complexes; and the paramount desire for uniqueness of opportunity on the part of all manners of expertise involved in this study. Consequently, the attempt herein is to present observations related to the above to devise a prospective process of *economic development* in the immediate impact area which could move through various potential steps and increments of implementation. These are based on studies to date which have been mentioned relative to the area's locational and resources advantages. Other potentials are being and would be explored further during the preconstruction planning stage. However, the potential analyzed below for which benefits are shown in Section V pertains to development of the Clarion - Armstrong County industrial potential to obtain continuation and betterment of the anticipated secondary economic effects which could stem from construction of the potential project and inducements offered to industrial and other developments. The process anticipated would not follow an altogether linear model, considering that the innovative aspects of the development plan would be less orderly and predictable than would be desired. Nevertheless, the project furnished water and related resources assets would be available to take fullest advantage of whatever development pattern would emerge.

Locational Considerations

The present program is confined to Clarion and Armstrong Counties mainly because of the project's objectives and physical capabilities relative to multiple-purpose water resources and locational advantages of the combined county areas. Advantages such as these would be conducive to economic development. Sites available for industrial development along the Allegheny River below the mouth of the Clarion River which could be made relatively flood free are shown on the potential developmental plan. These and adjacent off-river sites would furnish a substantial amount of land suitable for anticipated developments. The on-river sites made relatively flood-free could be used for heavier-type industry, such as a chemical or other industrial complex which could be located at a river-front site below the Clarion River entrance. Available on-river and off-river site areas offer a stable base for start of such a complex. These lands are located along the inland waterway system with connections to interstate highways. Railroad facilities are available also. A substantial amount of flat land highly suitable for industrial uses is available around and adjacent to the project area lands. Opportunely, available lands within the project area are so situated with existing infrastructure, that they could be devoted to induced private developmental use, especially a significantly located amount of land area in the Clarion-Strattonville area. Auxiliary lands in appropriate amounts, with good access, would be available to allow joint expansion of residential, commercial, public and quasi-public uses. Also, there could be established an appropriate relationship between access, development and urbanization of sites in a predominantly rural environment. The area of induced industrial and other developments would take advantage of the impoundment's resources as a focal point from which various land uses shown on Figures 11-6 and 11-29, would radiate. The entire development would be integrated between the downstream river potentials and those in surrounding and upstream reservoir and river stretches. The mass-transit system would link all of the plan elements, interspersing along the way a linear commercial facilities development, and providing for much needed contemporary housing. The waterway system and the reservoir, except for interruption by the dam, would become a continuum of developmental possibilities. The Foxview development at the lower end, and developmental facilities in the Clarion, Pennsylvania, area, which are enhanced by access provided by Interstate 80, are forerunners of the pattern which could gradually emerge. The impoundment possibility is viewed as hastening the development potential; however, if development could be achieved within the framework of the reservoir project, the future possibilities could be an outstanding example of well-conceived. and effectively planned and executed urban growth. Locationally, therefore, the entire project could be developed in a consistent way based upon the area's strongpoints which conjecturally, according to the chemical industry feasibility study, would place the chemical industry and the aluminum industry, both national growth industries, in position to take advantage of the area's strategic location with respect to raw materials, markets, mineral resources, labor

force, navigable waterway, access and transportation, and electric power. Other locations in the Monongahela and Ohio River Valleys probably could match various of these advantages, but none could equal the added initiative supplied to this potential by the St. Petersburg project and the scientific and cultural capabilities of Clarion State College.

Development possibilities herein are referenced to the chemical industry because of its national growth position. Other industries could be applied (and are) to the area. However, concentration of plan development to gauge expansion benefit potentials is focused on this industry as an example of the potential and of the kinds and amounts of secondary benefits which may be in the realm of credibility. Limestone and limestone products are reported to be one of the major sectors of the chemical industry analyzed as to areas of use currently supplied from outside the southwestern Pennsylvania area. In addition, the feasibility of development of these products, is functionally restricted to limestone deposits which are in proximity to a navigable river and existing or planned electric power stations, to permit integration with a chemical complex. Other arrangements of resources could conceivably achieve a similar expansion benefit situation. However, for this evaluation, the occurrence of limestone in Armstrong County is basic to consideration of a river-based chemical complex.

Concentration of flat lands of sufficient total area for an integrated development in any contiguous river reach investigated, is not as favorable a feasibility as that shown on Figure 11-6.. However, in addition, integrating the development of limestone with a chemical complex restricts areas for consideration to sites near navigable waters and within five miles of an electric power plant. These are important objectives to the credibility and profit situations because they permit low cost river transport of the bulk products of a chemical complex and also of bulk materials, and power rates are related to distance from the generator to the plant site. Vanport limestone, while not altogether the most advantageous from the standpoint of purity, occurs in varying degrees in the proximity of the Allegheny River from Kittanning to Bradys Bend. At Reesdale, a site adjacent to a West Penn Power steam generating plant, Vanport limestone occurs on the opposite bank of the river at the mouth of Mahoning Creek and at Templeton, a mile or two south of the site.

The study of an industrial complex in the Allegheny River below the St. Petersburg Reservoir area which was made in 1964, was circulated to the chemical industry in the ensuing period from 1966 up to the date of this report. The reports issued by EDA, develop the potential for a caustic-chlorine plant, an aluminum reduction plant, a synthetic abrasives plant, and a polyvinyl chloride plant, particularly at the Reesedale, Pennsylvania, site for the following respective locational reasons. Caustic-chlorine: site offers excellent prospects

for low cost salt by solution mining and low cost power from a modern station in the immediate vicinity; aluminum reduction: unique geographical location near Pittsburgh and heavy concentration of aluminum metal forming and fabrication industries located from Youngstown to Cleveland, overnight delivery by Interstate 80 of pig, billet, ingot, or hot metal, a power rate equivalent or below that of TVA and other utilities in Appalachia and the Ohio Valley, possibility of use of refractory-grade clays near Reesedale by combined mining of massive deposits in the area of both coal for fuel and clays for alumina; synthetic abrasives: proximity of Reesedale power plant and possibility that virgin grain of two non-metallic abrasives - silicon carbide and fused alumina - could be manufactured at competitive price as crude grain from Canada, from which furnished grit could be produced; and polyvinyl chloride: availability of low cost raw materials of bituminous coal, coke, salt and limestone and low cost power. These could, respectively, involve total investments in plants of $7.5, $88.0, $7.1, and $44.1 million. The caustic-chlorine plant appears to offer a stable base for the start of a chemical complex.

Clarion - Armstrong County Economic Development Potential

The St. Petersburg Reservoir project could contribute in large measure to the location of industry in the surrounding area, thus offering needed stimulation to economic growth in this sub-region. Principally, downstream streambank areas along the Allegheny River and those adjacent to the reservoir area in surrounding counties would be furnished project goods and services designed to provide a substantial addition to the existing water and related resource base. Particularly, the industrial development potential which could be attached to the resources potential would be especially significant in the Clarion-Strattonville area and would provide amenities to growth centers in the Clarion River headwaters. The project would provide water related inducements needed for spurring additional development and redevelopment of flood plain lands for industrial use along the Allegheny and Ohio River Main Stems, since it would offer industrial sites located in these flood plain areas a significant reduction in flood heights, producing a combination of flood free areas and those in which there would be an effectively improved flood damage frequency situation.

The feasibility study of locating a complex of chemical and aluminum industries along the Allegheny River, primarily at the Reesedale Site in Armstrong County about 30 miles downstream of the Clarion River, previously referred to (by Singmaster & Breyer, a group of professional consultants, under contract to the Economic Development Administration of the U. S. Department of Commerce), is considered as an example of a likely development which could be associated with the project. From the locational criteria of the industrial sectors broadly employed by the EDA consultants, which includes existing natural resources and water navigation plus competitively priced hydroelectric power generaation (such as from the reservoir project), it was concluded that this

area could offer a stable and attractive base for the start of these complexes. The feasibility study also considered factors reflecting the favorable possibility for the location of a chemical or aluminum complex at other sites along the Allegheny River and the Monongahela River. However, the effective combination of natural resources, project power and existing navigation, and proximity to markets, 1/ give more than a good possibility to realization of a chemical or aluminum complex in this area. It is projected that this could result in an increase in employment of up to 7,500 people in Armstrong and Clarion Counties alone. Satellite industries such as Aluminum Casting (3361) would possibly find similar favorable locational advantages in and around the impoundment area.

Transportation is indicated in the referenced studies to be a critical element of location. Since nearly half of the casting operations in this complex would be job shop castings to customer specifications, the need for consistent delivery and direct liaison with the customer is apparent. Superior highway transportation to automotive and appliance manufacturers of the East, North, Central and Middle Atlantic states by Interstate Route 80, which would bisect the proposed reservoir, would meet this requirement in that it provides high speed access to customers in Chicago, New York, Newark, Detroit and Cleveland. Transportation of molten aluminum has been so extended that plants in the Clarion area may receive it from the Armstrong County source, thereby eliminating costly metal reheating and capital outlay for furnace requirements. This contributes to a large locational factor advantage. Virtually all skills in the die castings plant could be derived through in plant training and vocational training in nearby schools. For most jobs, proficiency will be gained in a short period of time. For the skilled positions (tool and die, setup and maintenance) an extensive apprenticeship will be required. For managerial and corporative training, facilities of Clarion State College will offer a nucleus for expansion of technical knowledge by its present and projected programs and facilities, and by the research and training center proposed in the project plan.

Associated industry that could locate in the project area is the foamed plastic products industry (SIC 30.79.2). A major market for its products is in safety features in the automobile industry. The use of foamed plastic products in the nearby market area will increase over its present demand with current expansion of the automotive industry in New Stanton 2/ and other areas. Insulation for appliances also adds to market needs. It may be noted that the aluminum castings and this industry has identical customers which could lead to pooling of transportation costs to make one load and thus effect cost savings. No unusual or unique site criteria is needed for these industries. A well drained serviced site with good highway access would constitute

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1/ Fantus and Singmaster and Breyer
2/ Chrusler

the principal requirement. A tract of 15 to 20 acres would generally be sufficiently large to meet all expansion requirements. In-plant training and vocational schools could satisfy the labor skills required. Transportation costs to market would probably be the most important consideration in industrial site location for which the availability in the Clarion areas of a network of new and programmed high-speed highways to markets would fulfill this requirement.

The Armstrong-Clarion County area possesses several prime locational advantages conducive to potential economic development associated with the project. These include:

(1) A substantial amount of flat land highly suitable for industrial uses.

(2) Sufficient auxiliary land to allow joint expansion of residential, commercial, public, and quasi-public uses which will serve to balance the community's economy.

(3) Several large sites are ideally located next to the inland navigation system, with connections to interstate highways, with railroad facilities available at all sites.

(4) There is a large supply of unemployed and underemployed persons in the area, which would be adequate to supply new industry with labor over the long term.

(5) The St. Petersburg Reservoir would insure an adequate supply of water and electric power to satisfy industrial demand which may develop to the year 2020.

(6) Recreational facilities and very favorable aesthetic and environmental conditions are available in the Clarion area along with the project amenities.

Locational advantages cited above would be the basis by which the area would be made more attractive to growth industries. The initial industries which would be expected to locate here would be induced primarily by the possibilities to utilize the project generated electrical energy, and existing water transportation resources. Of these, the Chemical Industry and Primary Aluminum Smelting would be expected to locate earliest in the area. Later, development would be expected to center on satellite industries such as foamed plastics, aluminum fabricating, electrical components, paper and pulp and glass.

The two-county area from which the labor force could be drawn was evaluated in terms of present employment, unemployment, underemployment, and skill availability.

The available unemployed and underemployed labor force is unskilled, or semi-skilled, so that imported labor until about 1980 would be needed for managerial and skilled positions.

Clarion County has twelve boroughs and twenty-two townships. Only six townships and three boroughs registered a gain in population between 1940 and 1960. There was a 29.08% gain in Clarion Borough and Township, a 8.96% gain in Knox Borough and Beaver Township, and a 9.56% gain in Shippenville Borough and Elk Township. Gains were also recorded in Ashland Township (3.30%), Washington Township (8.45%), and Paint Township (53.83%). The growth center of this county is Clarion, Pennsylvania. Clarion County's major source of manufacturing employment is the glass industry which is located primarily in Clarion, with Knox and New Bethlehem as secondary centers. A bakery in Rimersburg, a wood furniture plant in New Bethlehem, and a TV receiver set plant in Hawthorne constitute the other major sources of manufacturing employment.

New industrial plants which could be located at Reesedale and Templeton in Armstrong County, and Maple Grove, Rimersburg, Clarion, Shippenville, and Knox in Clarion County would be expected to stimulate population growth in the Clarion County area.

The chemical industry, and aluminum smelter plant, if developed at Reesedale, would give impetus to satellite development in Clarion County. For example, an aluminum fabricating plant at Maple Grove near Rimersburg, due to its close proximity (15 miles), could receive molten aluminum from Reesedale in Armstrong County to eliminate costly investment necessitated by a reheating process, and be within ten miles of US 80, with its market access to Chicago and New York. A cellulosic man-made fiber plant (rayon) could be located at Catfish in Clarion County which could use wood-pulp waste from a pulp plant at Templeton in Armstrong County in the production of its products. Existing industry near Clarion which could have growth attributable to the potential reservoir, are Laurel Corp. (SIC 3732), a boat building concern in Paint Township near Shippenville, and Divio-Wayne Industries Inc. (SIC 3791), a concern engaged in the production of trailer coaches in Paint Township near Clarion. A number of firms engaged in production of electrical parts (SIC 36) and instruments (SIC 38) could be attracted to the Clarion area. A project related research and development institute to service the chemical complex in the surrounding area and Pittsburgh based industrial corporations, with Clarion State College as its focal point, could be considered as a distinct development possibility.

Armstrong County is composed of sixteen boroughs, twenty-eight townships, Parker City and the unincorporated towns of North Vandergrift and Troy Hill which are included in Parks Township and Rayburn Township, respectively. Of these forty-five political subdivisions, twenty-two had a population increase during the period 1940 to 1960 as shown on the enclosed table. Nineteen of these political subdivision gains were from 7% to 38%. The following definite trends are evident:

1. Shift from larger central cities in flood plain to outlying areas.

a. The boroughs of Ford City, Kittanning and Manorville, had a population loss while the surrounding area of Kittanning Township and Manor Township had a substantial gain.

b. The borough of Apollo had a population loss while surrounding Kiskiminetas Township had a substantial gain.

c. The borough of Freeport had a population loss while the surrounding area of South Buffalo Township had a substantial gain.

2. Shift from rural to urban.

a. Although the rural township of West Franklin has a population loss 3.70% from 1940 to 1960, Worthington borough had a 28.6% gain in population.

b. The borough of Atwood had a nominal 1.55% gain and Rural Valley, a 4.44% loss which is substantially below the 37.75% loss in Cowanshannock Township.

c. The borough of South Benthlehem loss of 9.09% was substantially below Mahoning Township's 21.40% loss.

3. Growth along Allegheny River and Kiskiminetas River.

a. Growth during the period 1940 to 1960 was in those townships bordering the navigable portion of the Allegheny River; the exception being the northern portion of Pine, Washington and Madison Townships.

b. Plumcreek and South Bend Townships have shown growth due to the construction of the Keystone (mine-mouth) power Plant and the greatly increased demand for coal from this area.

Armstrong County's main source of manufacturing employment is the glass industry located primarily in Ford City. A liquor distillery at Schenley is a secondary source of employment with the chemical industry, particularly a Nuclear Materials and Equipment Corporation at Apollo, the other major contributor.

From the above trends, the future population of Armstrong County will probably be more concentrated in those townships adjacent to the Allegheny River, especially in the southern portion of the county. Chemical plants located along the Allegheny River would stimulate this population growth in South Buffalo, Gilpin, Bethel, Manor, and North Buffalo townships. New plants at Reesedale and Templeton, however, could also be expected to have their employee's residences located in Clarion County.

On the above project induced possibility, the chemical industry could become the major source of employment in Armstrong County replacing the dominance of the existing glass industry which so far has failed to modernize sufficiently to employ the float-plate glass process. Machinery and fabricated metal products would also substantially enter the industrial mix of this county. Aluminum and wood products, although not contributing as a large sector of employment, would nevertheless contribute an economic impact of some magnitude.

Without the project economic development plan, normal increase in employment in the Armstrong-Clarion County area would not be expected to slow down its out-migration. The increase in manufacturing employment between 1940 and 1960 in OBE 6 was 128,000, and projected normal increase would be 172,000 from 1960 to 2020. The rate of increase in manufacturing employment between 1940 and 1960 was 1-1/2% or 48/32%; comparatively, the projected normal increase rate is 15/32%, or less than 1/3 the growth rate of the past. The rate of increase in total employment in the 1940 to 1960 period was 90/96% and the projected normal rate between 1960 and 2020, 80/96%, or less than the past. Even with a prorated share basis alloted to Armstrong-Clarion County, population and employment growth would be below the rest of Appalachia. However, there could be a change in location trends from old urban centers to new growth centers in rural areas, such as Armstrong and Clarion Counties, if the above discussed resources are available to complement it.

The economic study area presents a picture of high mobility among its young people. An average 1,000 persons per year in the prime employable working age left this area in the period 1940 to 1960. With even more entering this prime working age group during the period 1970-1990, the out-migration is projected to increase, related to the 1940 to 1960 period low birth rate of the depression and war years 1920 to 1940. In the period 1970 to 1990, out-migration could reach 1,200 per year, or a total of 24,000 people that new industries could hire plus 6,000 unemployed or underemployed who would remain. This potential labor force of 30,000 if held, would be available for employment in new industries.

One new metropolitan site has been proposed in Pennsylvania by the National Land Development Policy Committee (an unofficial committee), roughly in Clarion-Jefferson-Clearfield Counties along Interstate 80. This area might logically be selected as a demonstration model for a planned molecular city. This would have a significant impact on this region, particularly if the new metropolis location is made compatible with the potential reservoir project.

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SECTION IV - COST ESTIMATES

18. PROJECT COSTS

The total cost of construction of the St. Petersburg Reservoir is estimated to be $240,000,000. This includes $60,700,000 for hydropower facilities, $16,700,000 for pollution abatement, and $23,800,000 for the recreational development plan.

Estimates of first costs for the dam and reservoir and associated facilities include cost of initial construction, contingencies, engineering and design, and supervision and administration. Construction costs were based on detailed layouts and design considerations discussed in Section III. Unit prices for the cost estimates are based on prices for similar work performed in nearby areas and were adjusted to July 1967 price levels. Contingency allowances are 30% of the cost for land acquisition and damages and 20 and 25% for other features. Table 11-18 summarizes the first costs for St. Petersburg Reservoir project. Detailed estimates of first costs are shown in Table 11-19 with specific estimates for power and recreation facilities contained in Table 11-20 and 11-21.

Total investment costs and annual financial charges were developed for St. Petersburg Project based on data presented in the cost estimates. Investment costs include construction costs plus interest during construction. An interest rate of 3.25 percent and a construction period of 5 years was used to determine the interest during construction. Average annual charges were computed on the gross investment using the current Federal interest rate of 3.25 percent and an amortization period of 100 years. Operation and maintenance charges for the proposed developments are based on current costs of similar projects and include costs for major replacements where applicable. Detailed annual costs are shown in Table 11-22.

TABLE 11-18
SUMMARY OF FIRST COST

ST. PETERSBURG RESERVOIR PROJECT
(July 1967 Price Level)

Item	First Cost	First Cost With Indirect Costs Distributed
Lands and damages 1/	$24,000,000	$24,000,000
Pollution abatement 2/	15,000,000	16,700,000
Relocations	46,900,000	52,300,000
Reservoir clearing	4,000,000	4,510,000
Dam and appurtenances	51,800,000	57,700,000
Power plant (includes lands and damages) 3/	54,500,000	60,700,000
Recreation and fish and wildlife facilities 4/	21,400,000	23,800,000
Permanent operating equipment	70,000	79,000
Buildings, grounds and utilities	190,000	211,000
Engineering and design	12,400,000	-
Supervision and administration	9,740,000	-
TOTAL PROJECT COST (Rounded)	$240,000,000	$240,000,000

1/ Includes $2,500,000 for F & WL Mitigation and $4,000,000 specifically for general recreation, and excludes $30,000 for specific power facility lands.

2/ See Table 11-22 for details.

3/ See Tables 11-20 and 20a for details.

4/ See Tables 11-21 and 21a for details.

TABLE 11-19
DETAILED ESTIMATE OF LAND AND DAMAGES COST
ST. PETERSBURG RESERVOIR
(July 1967 Price Level)

Item	Unit	Quantity	Amount
JOINT USE LANDS			
Land	Acre	33,190	$ 1,742,000
Improvements	Set	790	8,388,000
Subtotal			$10,130,000
Contingencies (30%)			3,039,000
Severance	L.S.		45,000
Minerals	L.S.		171,000
Administration	L.S.		3,707,000
Resettlement	L.S.		408,000
Subtotal, Lands and Damages			$17,500,000
SPECIFIC USE LANDS FOR RECREATION			
Land	Acre	16,000	651,000
Improvements	Set	224	1,158,000
Subtotal			$ 1,809,000
Contingencies (30%)			543,000
Severance	L.S.		40,000
Minerals	L.S.		93,000
Administration	L.S.		1,266,000
Resettlement	L.S.		249,000
Subtotal, Lands & Damages			$ 4,000,000

*/ Includes $3,000,000 for acquisition of Piney Hydroelectric Power Facilities.

**/ The estimate of joint use land acreages and costs does not include the land requirements for the pumped storage installation. See Table 11-20 for this information.

TABLE 11-19 (CONT'D)
DETAILED ESTIMATE OF FIRST COSTS
ST. PETERSBURG RESERVOIR
(July 1967 Price Level)

Item	Unit	Quantity	Amount
WILDLIFE MITIGATION LANDS			
Lands	Acre	10,300*/	$ 393,000
Improvements	Set	103	475,000
Subtotal			$ 873,000
Contingencies (30%)			262,000
Severance	L.S.		-
Minerals**/	L.S.		-
Administration	L.S.		985,000
Resettlement	L.S.		280,000
Subtotal, Lands and Damages			$ 2,500,000
TOTAL LANDS AND DAMAGES			$24,000,000

Item	Unit	Quantity	Unit Price	Amount
RELOCATIONS				
Highways				
Class 1 Road	Mile	2.14	1,200,000	$ 2,568,000
Class 2 Roads	Mile	25.9	600,000	15,540,000
Bridges (3)	L.S.	-	-	4,500,000
Subtotal				$22,608,000
Utilities				
Power Lines	L.S.	-	-	$ 335,000
Telephone Lines	L.S.	-	-	410,000
Oil Lines	L.S.	-	-	682,000
Gas Lines	L.S.	-	-	743,000
Water Works	L.S.	-	-	400,000
Plug Oil & Gas Wells	ea	600.0	1,000	600,000
Subtotal				$ 3,170,000

*/ The area of the wildlife mitigation lands in 10,550 acres, 250 acres of which are accounted for in the above estimate of joint use lands.

**/ No minerals cost is considered because it is assumed that coal mining operations will be allowed to continue on the lands to be acquired for wildlife mitigation purpose.

TABLE 11-19 (CONT'D)
DETAILED ESTIMATE OF FIRST COSTS
ST. PETERSBURG RESERVOIR
(July 1967 Price Level)

Item	Unit	Quantity	Unit Price	Amount
RELOCATIONS (Cont'd)				
Railroads				
Track Work	L.S.	--	--	$ 520,000
Bridges (4)	L.S.	--	--	7,189,000
Tunnels (2)	L.S.	--	--	5,374,000
Subtotal				$13,083,000
Cemeteries (2)				
Graves	Each	1,000	235.00	$ 235,000
Subtotal				$39,096,000
Contingencies				7,804,000
TOTAL RELOCATIONS				$46,900,000
RESERVOIR CLEARING				
Complete Clearing to El. 1135				
Open	Acre	1,080	25.00	$ 27,000
Brush	Acre	3,250	125.00	406,000
Woods	Acre	6,450	400.00	2,580,000
Removal of Floatable Material				
El. 1135 to El. 1155	Job	1	Sum	50,000
Demolition of Buildings	Job	1	Sum	268,000
Archeological Survey and Salvage	L.S.*/			7,000
Subtotal				$ 3,338,000
Contingencies				662,000
TOTAL, RESERVOIR				$ 4,000,000
DAM AND APPURTENANCES				
Mobilization and Preparatory Work	Job	1	Sum	$ 850,000
Clearing and Grubbing	Acre	13	$875.00	11,375
Cofferdam and Care and Diversion of Water	Job	1	Sum	1,100,000
Common Excavation	Cu.Yd.	44,000	1.50	66,000
Rock Excavation	Cu.Yd.	482,500	4.00	1,930,000
Line Drilling	Sq.Ft.	168,500	2.00	337,000

*/ Funds to be provided and studies to be made by the National Park Service during advance planning.

TABLE 11-19 (CONT'D)
DETAILED ESTIMATE OF FIRST COSTS
ST. PETERSBURG RESERVOIR
(July 1967 Price Level)

Item	Unit	Quantity	Unit Price	Amount
Protection of Rock Surfaces				
a. Rock Bolts	Lin.Ft.	24,000	1.70	$ 40,800
b. Mesh Protection	Square (100')	1,200	26.00	31,200
Rock Fill	Cu.Yds.	45,000	5.00	225,000
Concrete				
a. Mass Concrete in Dam	Cu.Yds.	1,307,000	18.00	23,526,000
b. Spray Walls and Bridge Piers	Cu.Yds.	3,600	65.00	234,000
c. Training Walls	Cu.Yds.	25,000	50.00	1,250,000
d. Stilling Basin	Cu.Yds.	15,500	45.00	697,500
e. Structural Concrete	Cu.Yds.	300	75.00	22,500
Cement	Bbl.	1,013,700	5.00	5,068,500
Steel Reinforcement	Lb.	3,611,000	0.15	541,650
Copper Waterstop	Lin.Ft.	15,400	3.50	53,900
Steel Pipe Handrailing	Lb.	12,500	1.70	21,250
Aluminum Handrailing	Lin.Ft.	625	5.00	3,125
Aluminum Frames & Grating	Sq.Ft.	400	13.60	5,440
Steel Frames & Covers	Job	1	Sum	4,000
Exterior Hatches	Lb.	460	4.85	2,230
Structural Steel Ladders	Lb.	4,700	0.75	3,530
Aluminum Stair Treads	Lb.	7,200	2.75	19,800
Miscellaneous Metal	Lb.	9,200	1.12	10,300
Grout Hole Fittings	Each	700	10.00	7,000
Drain Hole Fittings	Each	175	186.00	32,550
Drain Hole Fittings Modified for Uplift Measurement	Each	7	310.00	2,710
Uplift Measurement Cell Installations	Job	1	Sum	9,400
Cast Manhole Frames, Covers, and Drains	Job	1	Sum	2,100
Scupper Pipes	Each	92	6.50	600
Sluice Vents	Job	1	Sum	72,300
Gage Well Metal	Job	1	Sum	4,000
Sluice By-Pass	Job	1	Sum	19,000
Miscellaneous Items	Job	1	Sum	3,700
Stilling Basin				
a. Drill 3" dia. Drain Hole	Lin.Ft.	11,000	1.00	11,000
b. Drill & Grout 3-1/2" dia. Holes for Anchor Rods	Lin.Ft.	10,000	4.50	45,000

TABLE 11-19 (CONT'D)
DETAILED ESTIMATE OF FIRST COSTS
ST. PETERSBURG RESERVOIR
(July 1967 Price Level)

Item	Unit	Quantity	Unit Price	Amount
Misc. Drainage Pipe	Lb.	47,000	.07	$ 3,290
Service Bridge	Job	1	Sum	173,600
Roadway Railing	Job	1	Sum	123,000
Sluice Gates (Including Liners & Outlet Armor)	Job	1	Sum	1,549,000
Hydraulic System	Job	1	Sum	81,800
Maintenance Bulkhead	Job	1	Sum	8,700
Bulkhead Frames & Tracks at all Sluices	Job	1	Sum	128,000
Pylon	Job	1	Sum	152,000
Pylon Plumbing & Drainage	Job	1	Sum	15,700
Pylon Heating	Job	1	Sum	14,200
Potable Water System	Job	1	Sum	8,300
Stand-By Unit	Job	1	Sum	20,000
Elevator	Job	1	Sum	75,000
Electrical	Job	1	Sum	317,000
Topsoiling & Seeding	Job	1	Sum	4,000
Flagpole	Job	1	Sum	3,000
Trash Boom	Job	1	Sum	43,000
Foundation Drilling & Grouting	Job	1	Sum	735,000
Project Information & Permanent Identification Signs	Job	1	Sum	1,250
Tainter Gates	Each	7	59,700.00	417,900
Tainter Gate Anchorages	Job	1	Sum	131,800
Tainter Gate Machinery	Job	1	Sum	362,200
Tainter Gate Machinery Housing	Job	1	Sum	27,300
Water Quality Control (W.Q.C.) Bulkheads & Guides	Job	1	Sum	131,000
W.Q.C. Bulkhead Trash Racks	Job	1	Sum	43,000
W.Q.C. Bulkhead Hoists	Job	1	Sum	67,100
W.Q.C. Bulkhead Hoist Housing	Job	1	Sum	10,500
Sump Pumping System	Job	1	Sum	15,600
Landscaping and Architectural Measures*/	Job	1	Sum	500,000
Subtotal				$41,426,200
Contingencies				10,373,800
TOTAL, DAM AND APPURTENANCES				$51,800,000

*/Includes beautification measures.

TABLE 11-19 (CONT'D)
DETAILED ESTIMATE OF FIRST COSTS
ST. PETERSBURG RESERVOIR
(July 1967 Price Level)

Item	Unit	Quantity	Unit Price	Amount
HYDROELECTRIC POWER*/	Job	1	Sum	$54,500,000
RECREATION**/	Job	1	Sum	21,400,000
PERMANENT OPERATING EQUIPMENT				
Communications				
Telephone	Job	1	Sum	300
Radio	Job	1	Sum	5,700
Transportation				
Boat and Outboard Motor	Each	1	$ 700.00	700
Jeep and Accessories	Each	1	3,500.00	3,500
Office Furniture and Equipment	Job	1	Sum	1,200
Maintenance Tools				
Mower, Small Power	Each	1	300.00	300
Mower, Highway Power	Each	1	2,000.00	2,000
Tools, Power and Hand	Job	1	Sum	3,500
Recording Gages				
Gages	L.S.	--	--	43,000
Subtotal				$ 60,200
Contingencies				9,800
TOTAL, PERMANENT OPERATING EQUIPMENT				$ 70,000
BUILDINGS, GROUND AND UTILITIES				
Operations Building	Job	1	Sum	$ 35,000
Maintenance Building	Job	1	Sum	63,500
Site Grading	Job	1	Sum	2,500
Sewage Disposal System	Job	1	Sum	12,000

*/For detailed cost estimate, see Table 11-20. Estimate includes $30,000 for lands and damages associated with the pumped storage installation.

**/For detailed cost estimate, see Table 11-21.

TABLE 11-19 (CONT'D)
DETAILED ESTIMATE OF FIRST COSTS
ST. PETERSBURG RESERVOIR
(July 1967 Price Level)

Item	Unit	Quantity	Unit Price	Amount
Landscaping	Job	1	Sum	$ 5,000
Water System	Job	1	Sum	5,000
Power Facilities	Job	1	Sum	12,000
Lightning Protection System	Job	1	Sum	2,000
Flag Pole	Job	1	Sum	2,300
Launching Ramp	Job	1	Sum	6,000
Parking Area	Job	1	Sum	17,500
Subtotal				$ 162,800
Contingencies				27,200
TOTAL, BUILDING, GROUNDS AND UTILITIES				$ 190,000
ENGINEERING AND DESIGN	L.S.	--	--	$12,400,000
SUPERVISION AND ADMINISTRATION	L.S.	--	--	$ 9,740,000
TOTAL PROJECT COSTS				$240,000,000

COST OF THE PUMPED STORAGE POWER INSTALLATION

The estimated first costs of the pumped storage power installation were developed primarily on the basis of cost data furnished by the Federal Power Commission. The costs are presented in the following table:

TABLE 11-20

ESTIMATED FIRST COSTS
POWER INSTALLATION

Item	Estimated First Costs
Lands and damages (including contingencies)	$ 30,000
FACILITIES:	
Waterways (suction tunnel, intake, discharge tunnel, vertical shaft and appurtenances, tailrace excavation and surge tank)	8,000,000
Powerhouse	22,000,000
Upper Reservoir	12,000,000
Regulating Dam	1,560,000
Subtotal	$43,560,000
Contingencies on Facilities	10,910,000
Subtotal, Facilities	$54,470,000
Subtotal, Lands and Facilities	$54,500,000
Engineering and Design	3,470,000
Supervision and Administration	2,730,000
Total, Rounded	$60,700,000

ANNUAL CHARGES

A summary of the estimated annual charges based on the first costs presented in Table 11-20 is presented in Table 11-20a. It is estimated that with proper operation and maintenance, and replacement of major items, the project will have a useful life of 100 years. The annual charges include

interest on the estimated Federal investment at 3¼ percent, the cost of ordinary operation and maintenance, and the cost of replacing major items having an estimated life of less than 100 years. In addition, 630,000 mwh of energy would be required during off-peak hours for pumping. The annual charges for pumping are based on a unit charge of $2.60 per megawatt hour suggested by the Federal Power Commission.

TABLE 11-20a

ESTIMATED ANNUAL CHARGES
POWER INSTALLATION

Item	Amount
Construction Expenditures	$60,700,000
Interest During Construction	4,930,000
Total Investment	$65,630,000
Annual Charges	
Interest on Investment (3¼%)	$ 2,133,000
Amortization of Investment (100 year life - 3¼% Interest Rate)	91,000
Operation and Maintenance	777,000
Major Replacements	137,000
Pumping Costs	1,638,000
Total	$ 4,776,000
(Rounded)	$ 4,780,000

COST OF RESERVOIR RECREATION FEATURES - Detailed estimate of the first cost of recreation facilities is shown in Table 11-21. The plan of recreational development for the St. Petersburg Reservoir assumes that all the initial facilities shown will be constructed at Federal-State expense at a total facility cost of $23,800,000, and that future facilities which are shown in Table 11-31 will be developed by private interests, at at a total facility cost of $38,600,000. In addition to this, the habitat improvement and real estate costs for general recreation purposes for the facilities would amount to an additional Federal-State expense of $4,050,000 and private expense of $150,000.

TABLE 11-21
ST. PETERSBURG RESERVOIR, CLARION RIVER, PENNSYLVANIA
DETAILED ESTIMATE OF INITIAL RECREATION,
FISH AND WILDLIFE,
AND WILDLIFE MITIGATION COSTS*/

Item	Unit	Unit Cost	Quantity	Amount
FACILITIES				
General Recreation				
Roads	Mile	$100,000.00	50	$ 5,000,000
Shelters	Each	15,000.00	29	435,000
Picnic Units	Each	500.00	1,460	730,000
Camping Units	Each	600.00	1,100	660,000
Parking (Cars)	Spaces	400.00	4,200	1,680,000
Parking (Cars and Trailers)	Spaces	500.00	880	440,000
Launching Ramps (12' Lane)	Each	3,000.00	22	66,000
Restrooms Including Water and Sanitation	Each	55,000.00	22	1,210,000
Restrooms Including Showers, Laundary, Water and Sanitation	Each	65,000.00	51	3,315,000
Beach (2)	Sq.Ft.	1.25	490,000	612,500
Beachhouse	Each	157,500.00	2	315,000
Overlook and Interpretation Center	Each	150,000.00	2	300,000
Walks and Trails	Mile	15,840.00	23	364,320
Amphitheater	Each	50,000.00	1	50,000
Landscaping	Job	570,000.00	Job	570,000
Campground Shelters	Each	3,500.00	25	87,500
Group Camp Units	Each	41,750.00	4	167,000
Boat Docks	Each	5,000.00	5	25,000
Signs	Job	75,000.00	Job	75,000
Playground Equipment	Job	275,000.00	Job	275,000
Administrative Unit	Job	45,000.00	Job	45,000
Subtotal				$16,422,000
Contingencies				4,078,000
Subtotal, General Recreation Facilities				$20,528,000
Rounded				$20,500,000
Fish and Wildlife				
Fishery				$ 100,000
Fishing Piers				150,000
Game Management				200,000
Car Parking				110,000
Boat Trailer Parking				124,000
Subtotal				$ 684,000
Contingencies				216,000
Subtotal, General Recreation and Fish and Wildlife Facilities				$21,400,000
Engineering and Design and Supervision and Administration				2,400,000
Total, General Recreation and Fish and Wildlife Facilities, Rounded				$23,800,000

TABLE 11-21 (CONT'D)
ST. PETERSBURG RESERVOIR, CLARION RIVER, PENNSYLVANIA

DETAILED ESTIMATE OF INITIAL RECREATION,
FISH AND WILDLIFE RECREATION,
AND WILDLIFE MITIGATION COSTS
(Continued)

Item	Unit	Quantity	Amount
Wildlife Mitigation			
Habitat Improvement (Non-Federal Cost)	Job	Job	$ 50,000
REAL ESTATE			
General Recreation (See Table 11-18)			
Total Cost Real Estate (General Recreation)			$ 4,000,000
Wildlife Mitigation (See Table 11-18)			
Land	Acres	10,550**/	-
Total Cost, Lands and Facilities (General Recreation and Fish and Wildlife Recreation), and Wildlife Mitigation			$27,850,000***/

*/ Initial general recreation facilities to be constructed with State-Federal funds. It is anticipated that future recreational development will be financed by private interest. Table 11-31 summarizes construction costs of future recreational development plan.

**/ Acquired as portion of joint project lands.

***/ Includes $50,000 Non-Federal Cost Habitat Improvement.

TABLE 21a
DETAILED SUMMARY OF CONSTRUCTION AND INVESTMENT COSTS,
ANNUAL CHARGES, ANNUAL BENEFITS AND VISITORS (IN 1,000'S)
GENERAL RECREATION AND FISH AND WILDLIFE RECREATION

	Initial Facilities
CONSTRUCTION COSTS:	
Facilities - Gen. Rec., F & WL	$23,800
Real Estate - Gen. Rec.	4,000
Total, Construction Costs	$27,800
INVESTMENT COSTS:	
General Recreation and Fish & Wildlife Construction	$23,800
Interest During Construction at 3¼% for ½ of 5 year construction period	1,935
Real Estate - Gen. Rec.	4,000
Interest During Construction at 3¼% for ½ of 5 year construction period	325
Total Investment, General and Fish & Wildlife Recreation Lands and Facilities, Rounded	$30,060
ANNUAL CHARGES: Specific-Use Lands & Facilities	
Interest on Investment 1/	$ 977
Amortization of Investment 1/	42
Major Replacement 2/	179
Direct Operation & Maintenance 3/	411
Total, Annual Financial Charges	$ 1,609
VISITATION:	
General REcreation	$ 3,360
Fishing (Pool)	169
Hunting	--
Total, Visitation	$ 3,529
BENEFITS:	
General Recreation	$ 3,890
Fishing (Pool)	169
Hunting	--
Total, Benefits	$ 4,059

1/ Interest (100 year project life) 3.25%, Amortization 0.1388%.
2/ Major Repoacement - Initial Facility Investment x 1/3 x 0.0252
$21,383,000 x 1/3 x 0.0252 = $179,000.
3/ Operation and Maintenance
General Recreation - $0.20 per visitor day of initial visitation
- $0.20 x 50% x 3,360,000 = $336,000
F&W 75,000
Total $411,000

Acid Drainage and Surface Control Measures for Pollution Abatement and Land Reclamation - The following estimate is a tabulation of the cost of a pollution abatement and land reclamation program to prevent or effectively abate acid drainage from drift mines, acid discharging oil and gas wells, acid producing surface mines and refuse piles, and other underground and surface acid-producing features; and land treatment measures in non-acid-producing surface mine areas. These would involve the necessary deep mine seals, surface sealing, oil and gas well plugging and surface area treatment for seepage, refuse pile removal and treatment, pre-installation studies and post-construction surveillance, and all other measures for adequate determination and implementation of effective acid drainage constrol and land surface treatment. These measures, as planned and cost estimated below in Table 11-22 for the Clarion River Basin, would be designed to establish an acceptable level of water quality for the St. Petersburg impoundment. The costs are broken down on the basis of reclaiming the acid contributing tributary watersheds which are the major producers of the acid pollution problem. 1/ The watershed and engineering studies shown below would be for the purpose of investigating the most effective construction procedures and applicable neutralization measures, and, modifications thereof during implementation, if necessary.

TABLE 11-22
ACID POLLUTION ABATEMENT AND LAND RECLAMATION

Description	Cost
Toby Creek (Jefferson Co.)	
Deep Mine Sealing (Drift Mines)*/	
60 seals @ $25,000	$1,500,000
Surface Sealing (Refuse Piles)**/	
144,000 cu. yds. @$2.00	288,000
Plugging Oil & Gas Wells***/	
35 wells @ $10,000	350,000
Sub Total	$2,138,000
Contingencies	212,000
Sub Total - Toby Cr. (Jeff. Co.)	$2,350,000
Toby Creek (Clarion Co.)	
Deep Mine Sealing (Drift Mines)*/	
5 seals @ $25,000	$ 125,000
Surface Sealing (Refuse Piles)**/	
30,000 cu. yds. @ $2.00	60,000
Surface Sealing (Strip Mines)**/	
800 acres @ $1,000	800,000
Plugging Oil & Gas Wells***/	
20 wells @ $10,000	200,000
Sub Total	$1,185,000
Contingencies	115,000
Sub Total - Toby Cr. (Clarion Co.)	$1,300,000

1/ Sources of Data - FWPCA Mine Drainage Source Investigation, Field Notes and Preliminary Field Investigation; Misc. Commonwealth of Pennsylvania Notes.

TABLE 11-22
ACID POLLUTION ABATEMENT AND LAND RECLAMATION (cont'd)

Description	Cost
Piney Creek	
Surface Sealing (Strip Mines)**/	
900 acres @ $1,000	$ 900,000
Plugging Oil & Gas Wells***/	
40 wells @ $10,000	400,000
Sub Total	$1,300,000
Contingencies	130,000
Sub Total - Piney Creek	$1,430,000
Mill Creek	
Surface Sealing (Strip Mines)**/	
800 acres @ $1,000	$ 800,000
Plugging Oil & Gas Wells***/	
31 wells @ $10,000	310,000
Sub Total	$1,110,000
Contingencies	220,000
Sub Total - Mill Creek	$1,330,000
Licking Creek	
Deep Mine Sealing (Drift Mines)*/	
35 seals @ $25,000	$ 875,000
Surface Sealing (Strip Mines)**/	
1200 acres @ $1,000	1,200,000
Plugging Oil & Gas Wells***/	
29 Wells @ $10,000	290,000
Sub Total	$2,365,000
Contingencies	475,000
Sub Total - Licking Creek	$2,840,000
Deer Creek	
Deep Mine Sealing (Drift Mines)*/	
10 seals @ $25,000	$ 250,000
Plugging Oil & Gas Wells***/	
38 wells @ $10,000	380,000
Sub Total	$ 630,000
Contingencies	120,000
Sub Total - Deer Creek	$ 750,000

TABLE 11-22

ACID POLLUTION ABATEMENT AND LAND RECLAMATION (Cont'd)

Description	Cost
Total of Above 6 Watersheds	$10,000,000
Land Reclamation (Not incl. in above) 3,000 acres @ $1,000	3,000,000
Watershed Study	500,000
Engineering Study	1,500,000
TOTAL DIRECT COST POLLUTION ABATEMENT	$15,000,000
Engineering & Design and Supervision & Administration	$ 1,700,000
TOTAL COST	$16,700,000

*/Mine opening seals, exploratory and observation drill holes and borehole camera surveys, Curtain Pressure Grouting Operations in Mine and Seepage Areas, De-watering, Air Shaft Sealing, etc.

**/Soil Treatment and Planting, Diversion Ditches and other Applicable Features

***/Concrete Plugs and Treatment of Seepage Areas, Diversion Ditches, possible multiple-openings for each well, etc.

TABLE 11-23
DETAILED ESTIMATE OF ANNUAL COST
ST. PETERSBURG DAM & RESERVOIR
July 1967 Prices

	Item	Financial Costs ($1,000) 3¼%	Economic Costs ($1,000) 3¼%
A.	Total Investment		
	(1) Recapitulation of project cost		
	(a) Initial costs	$240,000	$240,000
	(b) Market value of lands, (amount is included in line above)	(2,875)	(2,875)
	(2) Interest during construction (for ½ of construction period of 5 years)	19,500	19,500
	(3) Total gross investment	$259,500	$259,500
B.	Annual Costs		
	(1) Interest on investment	$ 8,434	$ 8,434
	(2) Adjustment for net loss of land $2,820,000 x (5% - 3¼%)	-	50
	(3) Amortization of investment	359	359
	(4) Maintenance & Operation		
	(a) Dam & Reservoir	272	272
	(b) Power (including pumping costs)	2,415	2,415
	(c) Recreation and fish & wildlife	411	411
	(5) Major replacements		
	(a) Dam & reservoir	18	18
	(b) Power	137	137
	(c) Recreation and fish & wildlife	179	179
	(6) Total annual costs	$12,225	$12,275

19. ECONOMIC DEVELOPMENT

That investment resulting from plant development on the Allegheny River and satellite plants resulting therefrom and those plants locating in the immediate vicinity of the project have been considered in the study.

To provide a basis for making preliminary cost and investment estimates, a developmental plan was prepared showing the proposed location of public and private land use activity. (See Figure 11-6). This developmental plan consisted of two components: (a) a land use plan; and (b) a transportation plan. Each component included the projected need for the land use or facility, a description of how the component was included in the development plan, and the estimated investment involved. Wtih these sketch plan elements it was then possible to calculate the estimated incremental increase in public and private investments expected during the fifty-year prospection period.

To establish the base for the induced economic investment in the Armstrong-Clarion County area, three types of long-range projections were made: (1) projections of employment, including both manufacturing and service jobs; (2) projections of population based on employment projections and residential holding capacity; and (3) income projections. These projections are developed by decade beginning in 1970 and covering the 50-year period to 2020 -- the period for which the study design was programmed.

Industrial

The following table presents the projected employment for the project area of influence. This employment base does not include existing manufacturing employment but rather reflects increases directly attributable to the water resources program. The initial employment increases were estimated by determining the industries most likely to locate on land made flood free by the project and the holding capacity of said land. The bridge to service and commercial employment was built by applying an employment multiplier of 0.74 to projected manufacturing employment.

TABLE 11-24
TOTAL EMPLOYMENT INCREASE RESULTING
FROM ST. PETERSBURG RESERVOIR

Year	Manufacturing Employment Increases 1/	Service Employment Multiplier	Service Employment Increases 1/	Total Employment Increases 1/
1970	0	.74	0	0
1980	1200	.74	888	2088
1990	2400	.74	1776	4176
2000	6001	.74	4440	10441
2010	6621	.74	4899	11520
2020	7041	.74	5210	12251

1/ Employment figures are cumulative by decade.

The total incremental increases in industrial investment, including plant and equipment, land and transportation (railroad spurs, access roads, etc.), by decade to year 2020 are presented in Table 11-25. These investments varied from a high of $85,000 per employee (Chemical Industry) to a law of $6,000 per employee (Apparel Industry).

TABLE 11-25
INCREMENTAL INDUSTRIAL INVESTMENT

Time Period	Industrial Employment Increase	Average Investment Per Employee	Investment ($1,000)
1970-1980	1200	$87,500	$105,000
1980-1990	1200	65,000	78,000
1990-2000	3600	31,380	113,000
2000-2010	620	17,740	11,000
2010-2020	420	16,670	7,000
		TOTAL INDUSTRIAL INVESTMENT	$314,000

Commercial

Commercial space requirements were based on estimates of volume of sales generated by the additional population projected for the project area of influence. It was assumed that current commercial activity is a function of present demands and additional commercial needs will increase in direct proportion to the capability of future population to support the new facilities.

Projected sales volume indicates that approximately 594,000 square feet of additional retail and service activity space will be required. Table 11-26 presents this need by decade based on a value of $60 of sales per square foot of space.

TABLE 11-26
POTENTIAL COMMERCIAL FLOOR AREA
NEEDS BY DECADE

Period	Potential Sales 1/ ($1,000)	Potential Sq. Footage 1/ (1,000)
1970-1980	$ 4,940	82
1980-1990	10,840	181
1990-2000	31,447	524
2000-2010	334,177	570
2010-2020	35,646	594

1/ Numbers shown are cummulative.

Studies were made in the general vicinity of the project to ascertain average investments in commercial areas (including features such as buildings, facilities, inventory, parking areas, land, etc.). The total investment by decade to year 2020 is projected at $13,498,000.

Commercial development would lag the industrial development due to some initial absorption by existing facilities. The phasing of commercial investment was based on expected employment income growth and is presented in Table 11-27.

TABLE 11-27
PHASING OF COMMERCIAL DEVELOPMENT

Period	Percent of Development	Amount ($1,000)
1970-1980	11.0	$1,485
1980-1990	15.0	2,025
1990-2000	18.6	2,511
2000-2010	25.2	3,401
2010-2020	30.2	4,076
	100.0	$13,498

Residential

Using the projected employment and factors relating employment to population derived from appropriate data contained in Appendix E, the associated population was determined. Table 11-28 presents these increases in population along with the required numbers of dwelling units required to accommodate this population.

TABLE 11-28
INCREASES IN POPULATION RESULTING FROM
PROJECT INDUCED DEVELOPMENT

Development Period	Est. Total Employment	Estimated Population	Required New Dwelling Units
1970-1980	2088	4,520	1,333
1980-1990	4176	9,829	2,918
1990-2000	10441	28,368	8,553
2000-2010	11520	30.823	9,315
2010-2020	12251	32,152	9,737

These projected increases could be absorbed in existing developed areas around cities such as Kittanning, Ford City, Leechburg, Freeport and Clarion without additional investments in hospitals, schools, fire protection, sewer and water trunklines and sewage and water treatment facilities that now exist or will be required to meet legal obligations of the State-Federal Water Pollution Control Laws.

The total new investment in this residential development over the 50 year period is estimated at $241,750,000. This cost includes raw land and improvement costs and structure costs to the purchaser. Table 11-29 summarizes this investment in residential development by decade.

TABLE 11-29
TOTAL RESIDENTIAL DEVELOPMENT INVESTMENT

	Number Dwelling Units	Density	Acres	Land Costs Acre, Including 25% Profit	Total Land Cost	Total Land Improvement Cost	Total Structure Cost	Total Investment
1970-1980	1335	2.5	535	$1,500	$ 802,500	$ 5,197,500	$ 20,025	$ 26,025,000
1980-1990	1585	2.5	635	1,750	1,111,250	7,000,000	28,530	36,641,250
1990-2000	5635	2.5	2255	2,500	5,637,500	24,000,000	112,700	142,337,500
2000-2010	762	2.5	305	3,000	915,000	2,091,250	17,145	20,151,250
2010-2020	422	2.5	170	3,500	595,000	1,000,000	15,000	16,595,000
	9739		3900		$9,061,250	$39,288,750	$193,400	$241,750.000

Summary

The following tables present, in summary, the incremental investments required for the overall developmental plan and the annual charges relating thereto.

TABLE 11-30
SUMMARY OF INCREMENTAL INCREASES IN
PUBLIC AND PRIVATE INVESTMENT BY DECADE
IN ARMSTRONG AND CLARION COUNTY, 1970 TO 2020 ($1000)

INVESTMENT CATEGORY

TIME PERIOD	INDUSTRIAL	COMMERCIAL	RESIDENTIAL	TOTALS
1970-1980	105,000	1,485	26,025	132,510
1980-1990	78,000	2,025	36,641	116,666
1990-2000	113,000	2,511	142,338	257,849
2000-2010	11,000	3,401	20,151	34,552
2010-2020	7,000	4,076	16,595	27,671
Totals	314,000	13,498	241,750	569,248

TABLE 11-31
SUMMARY OF DEVELOPMENTAL COSTS
1970 THROUGH 2020 ($1,000's)

Total Initial Investment	
Industrial and Commercial	$327,498
Commercial Recreation (Resort Plan)	22,200 1/
Residential	241,750
Total	$591,448
Present Worth of Investment	
Industrial and Commercial	$197,342
Commercial Recreation (Resort Plan)	13,185
Residential	118,144
Total	$328,671
Annual Charges 2/	
Industrial and Commercial	$ 9,942
Commercial Recreation (Resort Plan)	664
Residential	5,952
Total	$ 16,558

1/ Total investment in Resort Plan comprises $150,000 lands and damages, $14,700,000 facilities cost and reinvestment of 50% of facilities cost after 25 years. See detailed estimate Table 11-32.

2/ Average Annual Equivalent.

TABLE 11-32

CONSTRUCTION COST OF FUTURE RECREATIONAL
DEVELOPMENT PLAN

Item	Unit	Unit Cost	Quantity	Amount
FACILITIES				
Hotel	Job	Job	Job	$ 8,000,000
Motel	Job	Job	Job	1,250,000
Boatel	Job	Job	Job	666,700
Hostel	Job	Job	Job	666,700
Rental Cabins	Job	Job	Job	83,300
Marina	Each	$ 309,000	2	618,000
Skiing, Slopes, Etc.	Job	Job	Job	625,000
Golf, Including Clubhouse	Job	Job	Job	250,000
Horse Stable and Trails	Job	Job	Job	80,000
Subtotal Facilities				$12,239,700
Contingencies				2,447,940
Total Cost Future Recreation Facilities				$14,687,640
Rounded				$14,700,000
LAND AND DAMAGES				
Lands	900 ac.			$ 30,650
Improvements	5 sets			28,215
Contingencies				16,659
Severence				4,000
Minerals				20,000
Administration				45,000
Resettlement				5,000
Total Cost Lands and Damages				$ 149,524
Rounded				$ 150,000
TOTAL COST FUTURE RESORT RECREATION DEVELOPMENT PLAN				$14,837,164
Rounded				$14,900,000

SECTION V - BENEFITS

20. SUMMARY - Estimates of values, nationally and regionally, which can accrue from the St. Petersburg Dam and Reservoir project relate to user and many layered expansion benefits, which in their broad evaluation classifications have been estimated in tangible and intangible amounts. Table 11-33 summarizes project benefits in these respective categories, allowing that tangible user benefits are considered as monetary values of goods and services provided directly from the project (flood damage reduction, etc.); and tangible expansion benefits are values of increases in wages flowing directly from project construction by use of the project goods and services in combination with the project areas other resources. Likewise, intangible user and expansion benefits are related to effectiveness of the project in aiding a broad range of environmental improvements, so that an atmosphere can prevail in which the economy can expect diminishing hazards to life, public health, sanitation, etc., and additions to enhancements in living conditions by refurbishing and increasing the supply of amenity features and aesthetic attractions. The need is evident from qualitative and quantitative analyses in Chapter 12, Part II. In fact, the recent history of the Allegheny and Ohio Rivers is replete with bizarre details of harrowing human flood experiences and damages, deteriments to existence and propogation of fish and wildlife, and other environmental losses and permanent degradations. Obsolescence of municipal and structural developments have been accelerated by these situations to the point of indicating need for massive redevelopment programs. Clearly, the area in which water resources improvements can foster state and local self-help community improvement programs and attraction of private investments in community and industrial expansions and new diversified enterprises illustrates the field of real values, but of intangible costs.

Measuring techniques for determining monetary values for user benefits for flood control, land enhancement, recreation, fish and wildlife enhancement, water quality control and hydroelectric power, as can be attributed specifically to these purposes of the St. Petersburg Dam and Reservoir project, as formulated in the preceding Section II - Project Formulation, are shown below credited appropriately to national and regional accounts.

Subsequent paragraphs of this section describe the procedures and techniques used to measure the benefits creditable to the various elements of the plan. Table 11-33 is a summary of these benefits by category. The Table also credits appropriate values to the national and/or regional account.

TABLE 11-33

SUMMARY OF BENEFITS
ST. PETERSBURG RESERVOIR

Category and Class of Benefits	Annual Benefit ($1,000) National Account Only	Regional Account Only	National and Regnl Account	Total National Account	Total Regional Account
User Benefits					
Flood control	--	--	$ 2,162	$ 2,162	$ 2,162
Hydroelectric power	$2,110	--	6,330	8,440	6,330
Land enhancement	--	--	920	920	920
Water quality control	--	--	1,350	1,350	1,350
Recreation and Fish & Wildlife	203	--	3,856	4,059	3,856
Total user benefits	$2,313	--	$14,618	$16,931	$14,618
Expansion benefits					
Redevelopment	--	$ 2,030	$ 1,290	$ 1,290	$ 3,320
Development:					
Wages (service and Manufacturing	--	54,350	3,010	3,010	57,360
Wages (recreational expenditures)*/	--	4,158	332	332	4,490
Total expansion benefits	--	$60,538	$ 4,632	$ 4,632	$65,170
Total benefits	$2,313	$60,538	$19,250	$21,563	$79,788
Total Regional plus National Benefits					$82,101

*/ Computations on file in Pittsburgh District Office, U.S. Army Corps of Engineers.

21. USER BENEFITS

User benefits attributable to the proposed St. Petersburg Reservoir are divided among the following classifications: flood control, hydroelectric power, land enhancement, fish and wildlife, recreation, water supply and water quality. These benefits will contribute to the overall improvement in the economic well-being of the Nation and the immediate project area.

Flood Control

Flood discharges from the Clarion River add considerably to the flood heights on the Allegheny River downstream of the Clarion River and on the Ohio River below its mouth at Pittsburgh, Pennsylvania. Average annual flood damage reductions have been estimated for each of the damage districts along the Allegheny River and along the Ohio River downstream to mile 127.2. These estimates of average annual flood damage prevention have been derived from the stage-damage and stage-frequency data, both for the existing 13 reservoir system and the authorized Rowlesburg Lake within the Pittsburgh District in operation and with the addition of the potential St. Petersburg reservoir in operation. From the estimates for the various Pittsburgh District, Corps of Engineers, flood damage districts, the average annual flood control benefits from the potential St. Petersburg Reservoir would be $990,200. (See Table 11-34)

TABLE 11-34
Average Annual Primary Flood Damage (July 1967 Values)

Damage District	Total with Existing flood control measures Plus Rowlesburg Lake	Reduction by Clarion River Reservoir	Residual
Parker	$ 776	$ 586	$ 190
Kittanning	58,050	43,565	14,485
New Kensington	96,700	78,750	17,950
Pittsburgh	669,500	389,860	279,640
Montgomery	59,400	40,070	19,330
New Cumberland	191,000	117,484	73,516
Wheeling	506,665	287,485	219,180
Hannibal	106,300	32,440	73,860
Total (rounded)	$1,688,000	$990,000	$698,000

Preliminary benefit estimates based on the routing of 12 representative floods down the Ohio River below the limits of Sub-region F have been computed at approximately $1,019,000 for the average annual flood control benefits resulting from the operation of the St. Petersburg Reservoir. Therefore, the total average annual flood control benefits attributable to the St. Petersburg Reservoir amount to $1,143,000 */ + $1,019,000 = $2,162,000.

Enhancement Benefits

Benefits to the area required for the proposed expansion development are based on the expected increase in land value due to the water resource project. Current values of the land were determined and projections made of the future values, taking into consideration the location of the land relative to transportation facilities, utilities, etc. There are about 10,000 acres presently under- and unutilized subject to enhancement, having a present value of about $8,600,000 and a projected value of $30,000,000 after completion of the water resource project. Discounting this $21,400,000 increase to consider a 10 year conversion period (factor = 0.8641) and spreading over the project life at 5 percent interest rate (factor = 0.05058) provides an average annual equivalent enhancement value of about $920,000.

Recreation Benefits

An analysis of the general recreation potential of St. Petersburg Reservoir was made by the Bureau of Outdoor Recreation. (Appendix F) Ultimate attendance is estimated to be 3,360,000 recreation days annually. The benefit value per recreation day is estimated to be $1.25. Annual benefits for the general recreation use of the reservoir are estimated to be $3,890,000 (3,360,000 x 1.25 x 0.9259), the latter factor being one that reduces the benefits to an equivalent annual value based on an assumed exponential growth curve.

In addition to the above general recreation visitation, it is estimated that an additional 260,000 visitors per year would accrue to the future private recreational developments. The value of this visitation would be on the order of $3 to $6 per visitor day. Since this would be a result of private investment these benefits have not been considered here, but they have been included in the overall expansion benefit evaluation presented later in this section.

Fish and Wildlife

The bureau of Sport Fisheries and Wildlife evaluated the effects of the potential reservoir project on fish and wildlife resources in the area.

*/ Includes an additional $153,000 for benefits which will accrue to the proposed project as a result of normal future development expected to locate on the flood plain even in the absence of the project assuming an annual growth percent of 0.5 for a project life of 100 years.

(Appendix G) The net increase in fisherman-days is estimated to be 169,000 annually with a unit value of $1.00 per day resulting in annual benefits of $169,000. Losses in hunting opportunities would be mitigated by the acquisition of 10,300 acres (at project cost) adjacent to the reservoir area. This unit would be licensed to and managed by the Commonwealth of Pennsylvania.

Water Quality Control

The Federal Water Pollution Control Administration has established minimum flow criteria in the Ohio River at Sewickley, Pennsylvania, through year 2020. In order to provide flows of sufficient quantity to meet these requirements 110,000 acre feet of storage would be provided in the St. Petersburg Reservoir. Since there exists no other reservoir site of sufficient drainage area control in the Allegheny or Monongahela River Basins to provide these flows, the least costly alternative available would be a single purpose water quality reservoir of approximately 122,000 acre feet capacity (including sedimentation, evaporation and other losses), at or near the St. Petersburg site. Storage in the Clarion River Basin would also necessitate implementation of the acid mine drainage abatement program to provide water of acceptable quality. The cost of this reservoir and the abatement program would be as follows:

FIRST COST	
Dam and Reservoir Area (Including Abatement Program)	$58,600,000
Interest during construction @ 4,875% (3.14% for ! of 3 yr. construction period)	2,860,000
TOTAL INVESTMENT	$61,460,000
ANNUAL CHARGES	
Interest and Amortization ($3\frac{1}{4}$% - 100 year life)	$ 2,080,000
Annual Operation, Maintenance and Replacement	160,000
TOTAL ANNUAL CHARGES	$ 2,240,000*/
TOTAL ANNUAL WATER QUALITY BENEFITS	$ 1,350,000**/

*/This Total Annual Charge differs from that shown in FWPCA Appendix D due to revision of original alternative project.

**/Since flow augmentation from the St. Petersburg Reservoir will not be needed until year 2000, the benefits for water quality have been discounted at 3% resulting in an annual benefit of $1,350,000.

Hydroelectric Power

Where the demand exists, as is the case with the market area being considered in this report, it is reasonable to assume that the consumer would be willing to pay at least the cost that would be necessary to provide equivalent power and energy from the alternative source most likely to be developed in the absence of the project being considered. As indicated by the Federal Power Commission in its letter of 21 December 1967, the alternative source is considered to be a privately financed steam electric plant. The unit at site capacity and energy costs of this alternative represents the unit at-site capacity and energy values or benefits that would be attributable to the pumped storage development. To determine the unit value of power at the project, the estimated transmission cost incurred to bring the hydroelectric power to market with Federally financed facilities was deducted from the value of the power at the market area. these unit at-site values, as furnished by the Federal Power Commission are as follows:

Unit value for dependable capacity - $17.00 per kilowatt
Unit value for energy generation - $ 2.00 per megawatt-hour

Based on these unit power values, a dependable capacity of 420,000 kilowatts and an average annual generation of 650,000 megawatt-hours, the average annual power benefits would be $8,440,000 as shown in Table 11-35.

TABLE 11-35
ESTIMATED AVERAGE ANNUAL
POWER BENEFITS

Capacity component = 420,000 kw x $17.00/kw	$ 7,140,000
Energy component = 650,000 mwh x 2.00/mwh	1,300,000
Total	$ 8,440,000

COST OF ALTERNATIVE STEAM PLANT

The most likely alternative to a pumped storage development at St. Petersburg is considered to be the steam electric plan on which the Federal Power Commission based its estimates of power values. The previously discussed power values used in the benefit computations were based on private financing for the reason previously indicated. However, for the purpose of the COMPARABILITY TEST which is one of the requirements for economic justification, later discussed, it is necessary to determine the cost of the alternative plant on the basis of Federal financing. The unit costs of the alternative, at Federal financing were estimated at $9.00 per kilowatt of capacity and $2.00 per megawatt-hour of generation. Accordingly, the average annual cost of the steam electric alternative for the equivalent amount of capacity and energy produced at St. Petersburg, would be $5,080,000 as indicated in Table 11-36.

TABLE 11-36
ESTIMATED COST OF ALTERNATIVE
STEAM PLANT AT FEDERAL FINANCING

Capacity component - 420,000 kw x $9.00/kw	$ 3,780,000
Energy component - 650,000,000 mwh x $2.00/mwh	1,300,000
Total, average annual cost of alternative	$ 5,080,000

ECONOMIC JUSTIFICATION

The economic justification of the pumped storage installation considered herein was determined first by comparing the additional average annual benefits that would result from the power development with the average annual costs for construction and operation of these facilities. A summary of the average annual benefits, average annual costs, and the benefit-to-cost-ratio is presented in Table 11-37. A second requirement for economic justification is the comparability test. This involves the comparison of the average annual cost of the pumped storage installation against that of the most likely alternative in this case, the steam-electric plant previously discussed. A Federal interest rate is utilized to insure an equivalent basis on which to make the comparison. However, its use is not to be construed to imply that the Federal Government would or should build the alternative used in the comparison. As indicated in Table 11-37, the comparability test indicates that the pumped storage facilities would be less costly than the alternative. Accordingly, having passed both requirements, the St. Petersburg pumped storage installation is considered as economically justified.

TABLE 11-37
ECONOMIC JUSTIFICATION
OF PUMPED STORAGE DEVELOPMENT

Comparison of benefits to costs:	
Average annual benefits	$ 8,440,000
Average annual costs	4,780,000
B/C Ratio	1.8 to 1
Comparison of cost to alternative costs (comparability test):	
Average annual cost of alternative	$ 5,080,000
Average annual cost of pumped storage (favorable comparability)	4,780,000

22. EXPANSION BENEFITS

Expansion benefits are presented in two components; redevelopment and developmental. Redevelopment benefits consist of wage payments made to persons employed in the construction, operation and maintenance of the water resource plan. Developmental benefits are measured in terms of wage components made to persons not directly associated with the project, but whose employment results from the economic activity induced by the project.

Redevelopment Expansion Benefits - Redevelopment benefits credited to the regional account consist of the average annual equivalent of all labor used in construction, operation and maintenance of the water resource plan. Benefits credited to the national account are the wage payments made to persons who would otherwise be unemployed or underemployed in the absence of the project.

Analysis of construction costs of various reservoirs indicate labor costs to be about 30 percent of project construction costs excluding lands and damages, permanent operating equipment, engineering and design, and supervision and administration. Further analysis was made to determine the degree of skill required in project construction and what portion of these skills could be furnished from the locally unemployed or underemployed. The results of these studies are presented in the following table:

TABLE 11-38
LABOR SKILL REQUIRED FOR CONSTRUCTION,
OPERATION AND MAINTENANCE OF PROJECT

	Labor Required %	Supplies Locally %	Redevelopment Factor National Account	Redevelopment Factor Regional Account
Item				
Construction				
Skilled	56	25	0.14	0.56
Semi-skilled	17	50	0.08	0.17
Unskilled	27	100	0.27	0.27
TOTAL	100		0.49	1.00
Operation and Maintenance				
Skilled	40	25	0.10	0.40
Semi-skilled	30	50	0.15	0.30
Unskilled	30	100	0.30	0.30
TOTAL	100		0.55	1.00

The following table presents a summary of redevelopment expansion benefits credited to the regional and national accounts:

TABLE 11-39
REDEVELOPMENTAL EXPANSION BENEFITS

		Annual Redevelopment Benefits		
Item	Expenditure	Labor Costs (a)	National Account (b)	Regional Account
Construction	$194,000,000	$67,900,000	$1,130,000	$2,300,000
Annual Operation and Maintenance	1,460,000	1,020,000	160,000	1,020,000
TOTAL BENEFITS			$1,290,000	$3,320,000

(a) Labor cost is estimated to be 35 percent of construction costs less lands and damages, permanent operating equipment, engineering and design, and supervision and administration; and also 70 percent of operation and maintenance expenditures.

(b) Using 3¼ percent interest rate and the appropriate redevelopment factor, future benefits were discounted to reflect a 20-year time horizon.

Developmental Expansion Benefits - Developmental expansion benefits included in this report are measured in terms of profits and other wage and salary flows stemming from (a) the industrial and related developments attracted to the area by the project; (b) expenditures made by recreationists and tourists; and (c) economic activity induced by the responding of wages persons involved in project construction, operation and maintenance. The national account reflects the wages and salaries of persons who in the absence of the water resource development and accompanying developments would otherwise be unemployed and underemployed. The regional account includes all wages and salaries accruing within the sub-region as a result of the water resource project and related developments.

In making the determination as to which account (national or regional) into which benefits accrue for the selected plan, recognition was given to the very limited opportunity for development of attractive sites for expanding economic activity at other locations in the study area, to the reasonably favorable balance of industry locational characteristics other than attractive sites, and to the probability that a substantial amount of labor would remain unemployed or underemployed in the study area in the absence of the proposed plan regardless of other favorable forces which now or in the future may be at work within and beyond this boundary. Given these conditions and the level of development projected in the development plan which follows, wages and salaries which potentially may be occasioned by the development plan are shown on Figure 11-30.

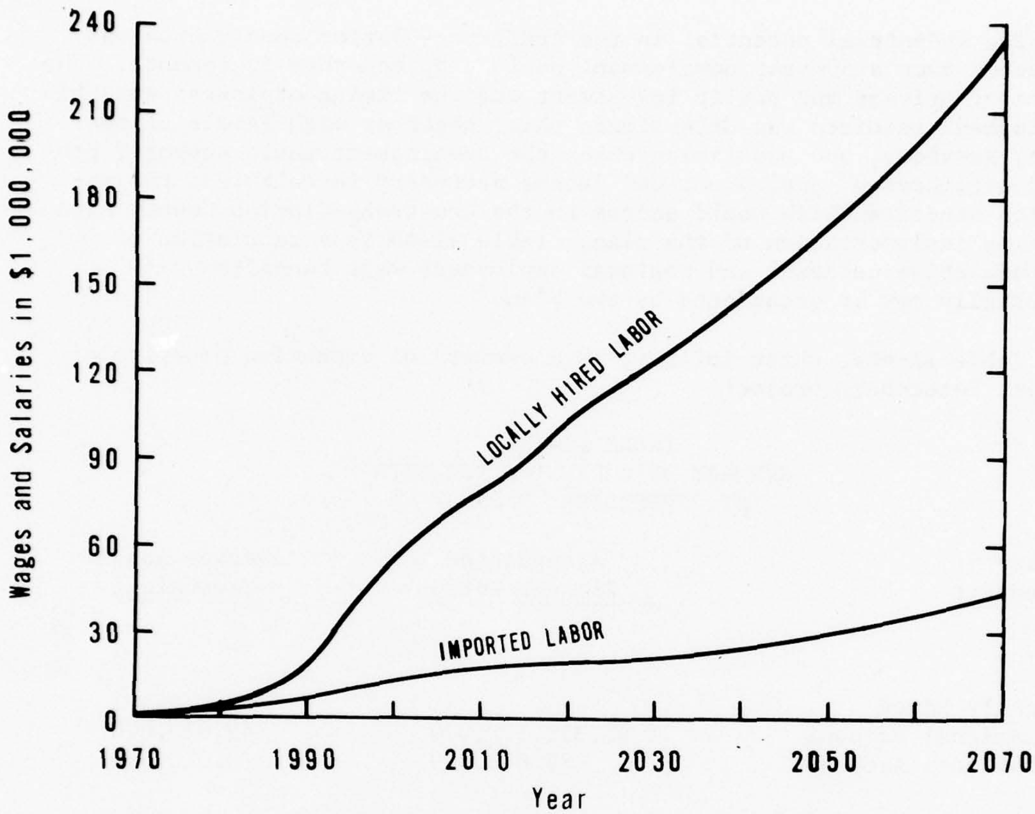

FIGURE II-30 WAGES AND SALARIES GENERATED BY THE PLAN

The local hires would normally be expected to be obtained from the ranks of unemployed or underemployed to the extent of the available supply. Those wages and salaries accruing to the unemployed or underemployed are normally credited to both the national and regional accounts as a measure of increased national productivity. However, in consideration of the forces presently at work to reduce unemployment and other programs which will probably be directed to that end in the future, the wages and salaries accruing to the national benefit account have been assumed to decline at a uniform rate to zero over a twenty year period.

A precise analytical procedure for making this kind of adjustment is not now available and the division between national and regional accounts must be recognized as being somewhat arbitrary and illustrative in nature.

The industrial potential in the Armstrong-Clarion County Area was projected over a 50-year development period, by ten-year increments. The amount of private and public investment and the timing of investment this development required was determined; this, together with levels of commerce, services, and population which the development would support, provided estimates of employment and income necessary to calculate the expansion benefits which would accrue to the Armstrong-Clarion County Area assuming implementation of the plan. Table 11-40 is a tabulation of the cumulative national and regional employment wage benefits which potentially may be occasioned by the plan.

Table 11-40a, which follows, is a summary of expansion benefits of the St. Petersburg project.

TABLE 11-40a
SUMMARY OF EXPANSION BENEFITS
ST. PETERSBURG PROJECT

Item of Benefit	Accumulated Present Worth	Average Annual Equivalent
Wages		
Locally Hired		
Regional Account	$1,352,372,000	$45,823,000
National Account	88,823,000	3,010,000
Imported		
Regional Account	$ 340,504,000	$11,537,000
Total Regional Account		$57,360,000
Total National Account		$ 3,010,000

TABLE 11-40
CUMULATIVE NATIONAL-REGIONAL EMPLOYMENT WAGE BENEFITS

	1980			1990			2000			2010			2020		
		Total Yearly Real Wages			Total Yearly Real Wages			Total Yearly Real Wages			Total Yearly Real Wages			Total Yearly Real Wages	
	Employees	1966 ($1,000)	1980 ($1,000)	Employees	1966 ($1,000)	1990 ($1,000)	Employees	1966 ($1,000)	2000 ($1,000)	Employees	1966 ($1,000)	2010 ($1,000)	Employees	1966 ($1,000)	2020 ($1,000)
IMPORTED															
Manufacturing, Management	100	750	990	200	1,500	2,430	500	3,750	7,350	551	4,132	9,875	586	4,395	12,789
Service, Management	89	534	704	89	534	865	89	534	1,047	89	534	1,276	89	534	1,554
Manufacturing, Skilled	263	1,229	1,620	263	1,229	1,991	263	1,229	2,409	263	1,229	2,937	263	1,229	3,576
Service, Skilled	222	888	1,171	222	888	1,439	222	888	1,740	222	888	2,122	222	888	2,584
Total	674	3,401	4,485	774	4,151	6,725	1,074	6,401	12,546	1,125	6,783	16,210	1,160	7,046	20,503
LOCALLY HIRED															
Manufacturing, Skilled	0	0		263	1,226	1,986	1,051	4,901	9,606	1,187	5,535	13,229	1,279	5,964	17,355
Manufacturing, Semi-skilled	512	1,631	2,153	1,024	3,261	5,283	2,561	8,157	15,988	2,826	9,001	21,512	3,005	9,571	27,852
Manufacturing, Unskilled	325	843	1,111	650	1,686	2,731	1,626	4,218	8,267	1,794	4,654	11,123	1,908	4,949	14,402
Service, Management	0	0		89	534	865	355	2,130	4,175	401	2,406	5,750	432	2,592	7,543
Service, Skilled	0	0		222	888	1,439	888	3,552	6,962	1,003	4,012	9,589	1,081	4,324	12,583
Service, Semi-skilled	355	853	1,124	710	1,705	2,762	1,776	4,266	8,361	1,960	4,708	11,252	2,084	5,006	14,567
Service, Unskilled	222	444	585	444	888	1,439	1,110	2,220	4,351	1,224	2,448	5,851	1,302	2,604	7,578
Total	1,414	3,771	4,973	3,402	10,188	16,505	9,367	29,444	57,710	10,395	32,744	78,306	11,091	35,010	101,880
TOTAL IMPORTED & LOCALLY HIRED	2,088	7,172	9,458	4,176	14,339	23,230	10,441	35,845	70,256	11,520	39,527	94,516	12,251	42,056	122,383

	National Account 1980 ($1,000)	Regional Account 1980 ($1,000)	National Account 1990 ($1,000)	Regional Account 1990 ($1,000)	National Account 2000 ($1,000)	Regional Account 2000 ($1,000)	National Account 2010 ($1,000)	Regional Account 2010 ($1,000)	National Account 2020 ($1,000)	Regional Account 2020 ($1,000)
Imported Labor		4,485		6,725		12,546		16,210		20,503
Locally Hired Labor	4,973	4,973	16,505	16,505	57,710	57,710	78,306	78,306	101,880	101,880
Total	4,973	9,458	16,505	23,230	57,710	70,256	78,306	94,516	101,880	122,383

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SECTION VI - ECONOMIC ANALYSIS

23. ECONOMIC DATA

Project Costs

Annual economic charges were computed utilizing data developed in the cost estimates presented in Section IV of this chapter. These charges differ slightly from the financial annual charges computed for the St. Petersburg Reservoir. The difference results from allowing for loss of land productivity which is based on 5 percent annual net income on lands taken for the project.

TABLE 11-41
SUMMARY OF ECONOMIC COSTS - ST. PETERSBURG DEVELOPMENT

Item	Cost ($1,000)
Total First Cost Water Resource Project	240,000
Interest	8,434
Amortization in 100 years	359
Operation & Maintenance	3,098
Major Replacements	334
Sub-total Financial Charges	12,225
Land Productivity Loss	50
TOTAL ANNUAL CHARGES, WATER RESOURCE PROJECT	12,275
Total First Cost Private Development	591,448
TOTAL ANNUAL CHARGES (See Para. 17)	16,558

Project Benefits

Annual economic benefits developed and discussed in Section V are summarized in Table 11-42.

TABLE 11-42
SUMMARY OF ANNUAL BENEFITS FOR
ST. PETERSBURG DEVELOPMENT

Type of Benefit	Annual Benefit ($1,000) National Account	Regional Account
User	16,931	14,618
Redevelopment	1,290	3,320
Development	3,342	61,850
TOTAL BENEFIT	21,563	79,788
User plus Redevelopment	18,221	17,938
Expansion (Redevelopment plus Development)	4,632	65,170

24. INDICES OF PERFORMANCE

One index of performance can be evaluated by reliance on the conventional ratio of benefits to costs generally developed for water resources projects. The numerator consists of annual user benefits plus those employment benefits attributable to direct construction, operation and maintenance of the water project (redevelopment benefits). The denominator is the annual economic cost of the water project. Such an index for the St. Petersburg reservoir project computed below, expresses the minimum index of performance in regard to national income augmentation.

$$\frac{\text{User plus redevelopment benefits}}{\text{Annual economic cost}} = \frac{\$18{,}221{,}000}{\$12{,}275{,}000} = 1.5$$

Another index of performance gives a relative measure of the contribution that the St. Petersburg development would make to the objective of employment expansion. The numerator consists of increased wage payments for construction, operation and maintenance of the water project plus wages and salaries and other income flows to the region generated by the associated private investments. The denominator is the annual cost, both public and private, necessary to provide the expansion in employment opportunities.

$$\frac{\text{Redevelopment plus development benefits}}{\text{Total annual cost of plan}} = \frac{\$65{,}170{,}000}{\$28{,}833{,}000} = 2.3$$

25. ALLOCATION OF COSTS

Costs of the St. Petersburg Reservoir Project were allocated by the separable cost-remaining benefits method modified to accommodate regional income expansion as a purpose. Purposes among which costs are allocated include flood control, power, water quality control, recreation and regional income expansion. Table 11-43 summarizes the construction expenditures, annual operation, maintenance and major replacement costs, total capital and investment costs and annual charges. Figure 11-31, page III-11-241 shows the features of projects utilized in Table 11-43. Cost allocations are given in Table 11-44.

Alternative Costs

To provide an equitable basis for allocation of project costs to each purpose, the benefits for each purpose were limited to the cost of providing an alternative single-purpose project, where such alternate costs would be less than or equal to the estimated benefit.

The alternative cost for flood control as summarized in Table 11-43, were based on actual estimates of the cost of providing a single-purpose flood control project at the site selected for the multiple-purpose project. The alternative cost for recreation were developed from statistical data compiled by the Corps of Engineers reflecting cost of single-purpose developments undertaken by State parks in Ohio River Basin States.*/ Alternative costs for water quality control were developed by the Corps of Engineers as discussed in paragraph 21. The alternative cost of power were furnished by the Federal Power Commission, based on costs for a Federally financed steam plant in the general project area. The value assigned as an alternative cost for regional income expansion is not based on a relevant alternative program for providing similar income effects, because the full range for alternative means of obtaining these benefits have not been evaluated. To maintain the principal of the SCRB cost allotation procedure, the total cost of the water project and associated costs have been entered as a limit on cost to be allocated to regional income expansion.

Separable Costs

The incremental cost for adding each purpose to the multiple-purpose project was calculated by estimating the savings which would accrue if that purpose were omitted and all other purposes were maintained in the project.

Restricted Joint Costs

In the case of power, water quality, and recreation the pool resulting from the storage allocations to the three purposes is jointly used by the three purposes, but not by flood control. Therefore, the cost of adding the total storage increment represented by these three purposes

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*/ On file in Pittsburgh District Office, U.S. Army Corps of Engineers.

TABLE 11-43

ST. PETERSBURG RESERVOIR
SUMMARY OF COSTS ($1,000)
WITH POWER AND WITH REGIONAL INCOME EXPANSION

	MULTIPLE PURPOSE PLAN											MULTIPLE PURPOSE PROJECT LESS:				
	Specific Use Lands and Facilities							Alternate Single Purpose Projects								
Item	Flood Control	Power	Water Quality	Recreation	Regional Income Expansion	Joint-Use Land and Facilities	Total Costs	Flood Control	Power	Water Quality	Recreation	Flood Control	Power	Water Quality	Recreation	Regional Income Expansion
Construction First Costs:																
ST. PETERSBURG PROJECT																
Lands and damages				4,000		20,000	24,000	10,300		5,000		24,000	24,000	24,000	20,000	24,000
Pollution abatement						16,700	16,700	-		13,504		16,847	16,716	16,700	16,826	16,700
Relocations						52,300	52,300	( )		7,876		( )	52,265	52,300	52,610	52,300
Reservoir and pool preparation						4,510	4,510	(75,263)		1,013		(84,574)	4,460	4,510	4,487	4,510
Dam and appurtenances			350			57,350	57,700	( )		30,913		( )	57,725	57,350	58,108	57,700
Power plant		60,700				-	60,700	-		-		61,212	-	60,700	61,136	60,700
Recreation facilities				23,800		-	23,800	-		-		24,036	23,850	23,800	-	23,800
Permanent operating equipment						79	79	82		80		80	72	79	80	79
Building, grounds and utilities						211	211	217		214		213	212	211	213	211
TOTAL, ST. PETERSBURG PROJECT		60,700	350	27,800	-	151,150	240,000	85,862		58,600		210,962	179,300	239,650	213,460	240,000
ECONOMIC DEVELOPMENT PLAN					591,448		591,448					591,448	591,448	591,448	591,448	-
TOTAL CONSTRUCTION COSTS		60,700	350	27,800	591,448	151,150	831,448	85,862		58,600		802,410	770,748	831,090	804,908	240,000
Investment Costs:																
ST. PETERSBURG PROJECT																
Construction costs		60,700	350	27,800	-	151,150	240,000	85,862		58,600		210,962	179,300	239,650	213,462	240,000
Interest during construction		4,930	29	2,260	-	12,281	19,500	6,976		2,860		17,141	14,568	19,472	17,344	19,500
TOTAL, ST. PETERSBURG PROJECT		65,630	379	30,060	-	163,431	259,500	92,838		61,460		228,103	193,868	259,122	230,806	259,500
ECONOMIC DEVELOPMENT PLAN		-	-	-	591,448	-	591,448					591,448	591,448	591,448	591,448	-
TOTAL INVESTMENT COSTS		65,630	379	30,060	591,448	163,431	850,948	92,838		61,460		819,551	785,316	850,570	822,254	259,500
Annual Financial Charges:																
ST. PETERSBURG PROJECT																
Interest (.0325)		2,133	12	977	-	5,312	8,434	3,017		1,203		7,413	6,301	8,421	7,501	8,434
Amortization 100 year (.00138)		91	-	42	-	226	359	128		51		315	268	358	318	359
Operation and maintenance																
Dam						272	272	200		90		230	272	272	272	272
Power		2,415					2,415					2,415	-	2,415	2,415	2,415
Recreation				411			411					411	411	411	-	411
Major replacements																
Dam						18	18	13		6		15	18	18	18	18
Power		137					137					137	-	137	137	137
Recreation				179			179					179	179	179	-	179
TOTAL, ST. PETERSBURG PROJECT		4,776	12	1,609	-	5,828	12,225	3,358		1,350		11,115	7,449	12,211	10,661	12,225
ECONOMIC DEVELOPMENT PLAN					16,558	-	16,558	-		-		16,558	16,558	16,558	16,558	-
TOTAL ANNUAL FINANCIAL CHARGES		4,776	12	1,609	16,558	5,828	28,783	3,358	5,080	1,350	2,740	27,673	24,007	28,769	27,219	12,225

TABLE 11-44
ALLOCATION OF COSTS ($1,000)
SEPARABLE COSTS - REMAINING BENEFITS METHOD
ST. PETERSBURG RESERVOIR, PENNSYLVANIA
WITH POWER AND WITH REGIONAL EXPANSION EFFECTS

	Item	USER EFFECTS				Regional Expansion Effects	Total
		Flood Control	Hydro-Power	Water Quality	Recreation		
1.	Benefits	2,162	8,440	1,350	4,059	65,170	81,181
2.	Alternative costs	3,358	5,080	1,350	2,740	28,783*/	41,311
3.	Benefit limits	2,162	5,080	1,350	2,740	28,783	40,115
4.	Separable costs	1,110	4,776	14	1,564	16,558	24,022
5.	Remaining benefits (3-4)	1,052	304	1,336	1,176	12,225	16,093
6.	Allocation of restricted joint costs						
	a. Remaining benefits	0	304	1,336	1,176	0	2,816
	b. Ratio	0	.1080	.4744	.4176	0	1.000
	c. Allocated restricted costs	0	271	1,192	1,050	0	2,513
7.	Separable plus allocated restricted costs (4+6c)	1,110	5,047	1,206	2,614	16,558	26,535
8.	Remaining benefits (3-7)	1,052	33	144	126	12,225	13,580
9.	Ratio	.0775	.0024	.0106	.0093	.9002	1.000
10.	Allocated joint costs	174	5	24	21	2,024	2,248
11.	Total allocated financial coast (7+10)	1,284	5,052	1,230	2,635	18,582	28,783

*/ Based on Average Annual for Multiple Purpose Project

TABLE 11-44
ALLOCATION OF COSTS ($1,000)
SEPARABLE COSTS - REMAINING BENEFITS METHOD
ST. PETERSBURG RESERVOIR, PENNSYLVANIA
WITH POWER AND WITH REGIONAL EXPANSION EFFECTS

	USER EFFECTS				Regional	
Item	Flood Control	Hydro-Power	Water Quality	Recreation	Expansion Effects	Total
12. Separable O, M & R charges	45	2,552	0	590	0	3,187
13. Allocated joint O, M & R charges	19	1	3	2	220	245
14. Total allocated O, M & R charges	64	2,553	3	592	220	3,432
15. Annual investment costs (11-14)	1,220	2,499	1,227	2,043	18,362	25,351
16. Total allocated investment costs	36,010	73,760	36,216	60,301	644,661*/	850,948
17. Investment in specific use lands and facilities	0	65,630	379	30,060	591,448	687,517
18. Investment in joint use lands and facilities (16-17)	36,010	8,130	35,837	30,241	53,213	163,431
19. Interest on joint use lands and facilities	2,706	611	2,693	2,272	3,999	12,281
20. Allocated construction costs of joint use lands and facilities (18-19)	33,304	7,519	33,144	27,969	49,214	151,150

*/ Adjusted to take care of discrepancy due to rounding.

TABLE 11-44
ALLOCATION OF COSTS ($1,000)
SEPARABLE COSTS - REMAINING BENEFITS METHOD
ST. PETERSBURG RESERVOIR, PENNSYLVANIA
WITH POWER AND WITH REGIONAL EXPANSION EFFECTS

	Item	USER EFFECTS Flood Control	Hydro-Power	Water Quality	Recreation	Regional Expansion Effects	Total
21.	Construction costs of specific use lands and facilities	0	60,700	350	27,800	591,448	680,298
22.	Total allocated construction costs (20+21)	33,304	68,219	33,494	55,769	640,662	831,448
23.	Construction costs of regional expansion	0	0	0	0	591,448	591,448
24.	Construction costs of St. Petersburg Reservoir (22-23)	33,304	68,219	33,494	55,769	49,214	240,000

was calculated, the sum of the separable cost already allocated to each purpose subtracted from this gross incremental cost, and the residual allocated to each of the three purposes in the ratio of benefits that remains. Restricted joint costs amount to $2,513,000 (See Table 11-44).

Joint Costs

Joint costs were allocated to each purpose according to the ratio of benefits remaining after separable costs were allocated.

Costs Allocated to Recreation

The costs allocated to recreation have been sub-allocated between general and fish and wildlife recreation programs in Table 11-45.

TABLE 11-45
SUB-ALLOCATION - ALLOCATED RECREATION COSTS

Recreation	Benefits ($1,000)	Ratio	Allocated Construction Costs ($1,000)
General	3,890	0.96	53,538
F&WL	169	0.04	2,231
Total			55,769

Costs Allocated to Power

The costs of the pumped storage development presented in Table 11-43 are only those additional costs that would be required to include power as a project purpose without any charges against power for use of the St. Petersburg Reservoir. However, certain facilities of the project, though not specifically for power, would serve multiple uses, including power. Therefore, pumped storage power should assume its equitable share of these costs. This was determined by means of an allocation of costs, using the Separable Costs - Remaining Benefits Method. A project life of 100 years was used for economic evaluation and cost allocation. A summary of the costs allocated to pumped storage hydropower is presented in Table 11-46. Detailed cost allocation data are presented in Table 11-44. These allocations are considered reasonable but they are preliminary and are used only for the purpose of this report. In accordance with standard practice, this preliminary allocation will be reviewed and brought up to date when funds for initiation of construction are being requested. A tentative cost allocation will be prepared as soon as practical after construction is initiated; and a final allocation of costs, based upon the actual costs incurred, by the time the project is placed in operation.

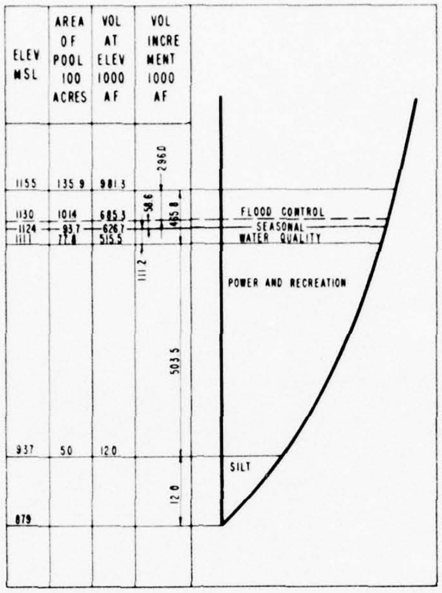
TABLE 11-46
COSTS ALLOCATED TO PUMPED STORAGE HYDROELECTRIC POWER
($1,000)

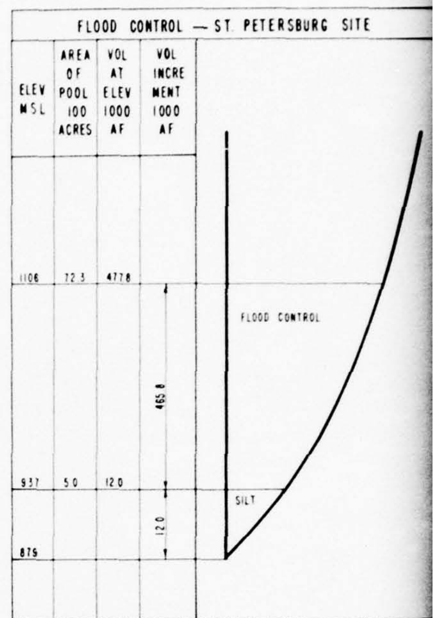
Item	Allocated Costs
Construction expenditures	68,219
Investment	73,760
Total annual costs	2,499

PROJECT FEATURES, COST ALLOCATION
ST. PETERSBURG RESERVOIR, PENNSY

ALTERNAT

MULTIPLE PURPOSE PROJECT





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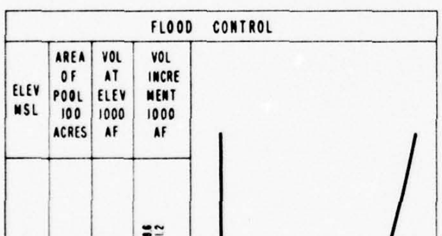

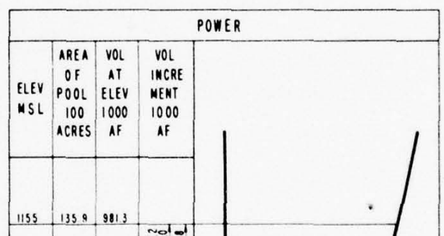

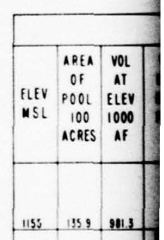

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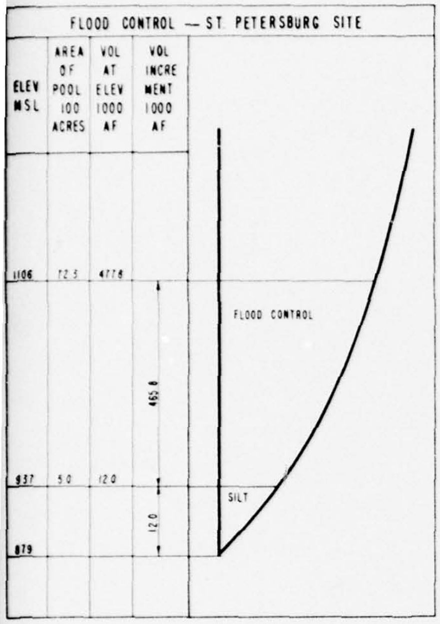
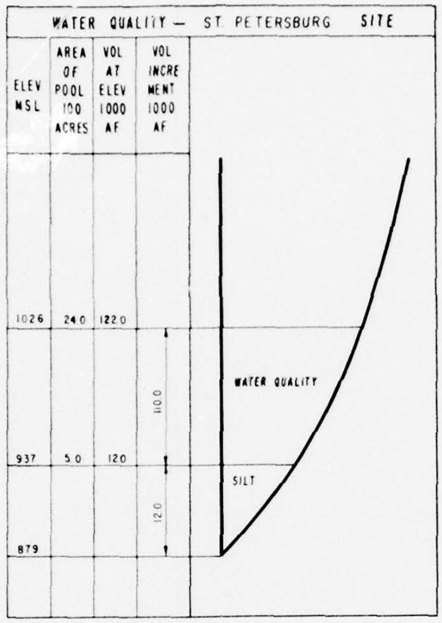
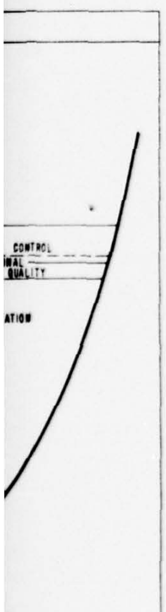
T FEATURES, COST ALLOCATION STUDIES
TERSBURG RESERVOIR, PENNSYLVANIA

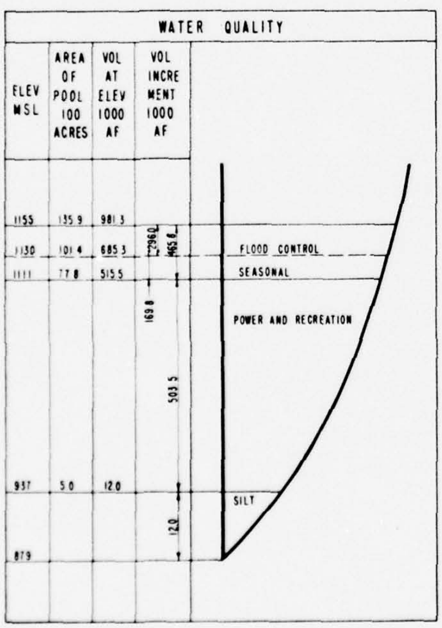
ALTERNATE SINGLE PURPOSE PROJECTS





MULTIPLE PURPOSE PROJECT LESS





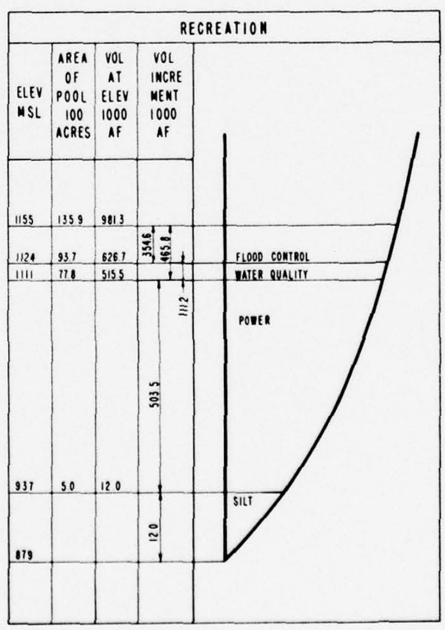


FIGURE II-31

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SECTION VII - COST SHARING

26. GOVERNING LEGISLATION

Apportionment of costs for the multiple-purpose St. Petersburg Reservoir (with power) between Federal and non-Federal interests is made according to the following criteria and summarized in Table 11-48.

Flood Control

All costs allocated to flood control are apportioned to the Federal Government in accordance with Section 201 of the Flood Control Act of 1958 (PL 85-500). The effects of the project are widespread because of the large economic impact over the multi-county area along the Allegheny and Ohio Rivers to below the sub-region limits.

Water Quality Control

All costs allocated to water quality control, including project associated program for acid mine drainage pollution abatement and strip-mine reclamation, are apportioned to the Federal Government according to the Water Pollution Control Act of 1961 (PL 87-88). Widespread benefits accrue to the project because of the economic impact of the project services on the Allegheny and Ohio Rivers. The Commonwealth of Pennsylvania would have jurisdiction over future control of mining, reclamation, pollution control, and conversion of areas to best project and associated uses. The balance of the abatement - reclamation program relevant to areas outside of project improvements would be under jurisdiction of and funding by the Commonwealth of Pennsylvania with whatever financial resources are available under current bonded programs or under other applicable Federal-State cost sharing legislation.

Water Supply

Replacement of Clarion's water supply will be necessary because of inundation of present source and will be non-reinbersable.

All costs allocable to future water supply would be apportioned to non-Federal interests in accordance with the Water Supply Act of 1958 (Title III, PL 85-500).

Power

All costs allocated to hydroelectric power are apportioned to the Federal Government. Section 5 of the Flood Control Act, approved 22 December 1944, provides that electric power and energy generated at reservoir projects under the Department of the Army over and above the energy required for operation of the project shall be turned over to the Secretary of the Interior for disposal.

The hydroelectric power capacity of the proposed reservoir, if developed by non-Federal interests, would result in a benefit justifiably allocable to the developer. The determination of the amount of remuneration due to the Federal Government, should the power capacity of the reservoir be developed by non-Federal interests, would be determined by the Federal Power Commission under existing regulations.

Recreation

Costs allocated to recreation at St. Petersburg Dam and Reservoir are apportioned to the Federal Government and the Commonwealth of Pennsylvania according to the Federal Water Project Recreation Act of 1965 (PL 89-72). This Act requires that non-Federal interests agree to administer project land and water areas for recreation and fish and wildlife enhancement and bear not less than one-half the separable cost for these purposes, and all the separable costs for operation, maintenance and replacement. One-half of the allocated separable construction costs are estimated to be $13,900 (See Table 11-47). Estimated Annual Operation, Maintenance and Replacement Costs are estimated to be $590,000. The remaining joint-use construction, operation and maintenance expenditures allocated to recreation are apportioned to the Federal Government.

TABLE 11-47
RECREATION APPORTIONMENT BETWEEN FEDERAL & NON-FEDERAL

Separable Costs of Recreation	($1,000)
Lands	4,000
Facilities	23,800
Storage	0
Total	27,800*/
Cost Sharing	
Federal	13,900
Non-Federal	13,900

*/ From specific use cost summary in cost allocation: calculated separable construction costs are somewhat smaller because of shift in overhead rates for E&D, S&A.

Resettlement

Provisions of Section 209, 1968 Omnibus Rivers and Harbors Act, may be utilized for resettlement of families, individuals, and business concerns displaced by the project upon request of the Governor of the Commonwealth of Pennsylvania, and after consultation with appropriate

Federal, State, interstate, regional, and local departments. Section 209 essentially provides for early acquisition of lands by the Secretary of the Army, subject to repayment by local and State interests, from funds made available for such purposes by other appropriate Federal agencies for orderly planned resettlement of those displaced persons who desire to be relocated.

TABLE 11-48
APPORTIONMENT OF COSTS BETWEEN FEDERAL AND NON-FEDERAL INTERESTS - ST. PETERSBURG RESERVOIR, PA.

Project Purpose	Construction Costs ($1,000) Federal	Non-Federal	Total	Annual Operation, Maintenance & Replacement ($1,000) Federal	Non-Federal	Total
Flood Control	33,304	0	33,304	64	0	64
Power	68,219	0	68,219	2,553	0	2,553
Water Quality	33,494	0	33,494	3	0	3
Recreation	41,869	13,900	55,769	2	590	592
Development	49,214	0	49,214	220	0	220
Total	226,100	13,900	240,000	2,842	590	3,432

27. STATE AND LOCAL ASSURANCES

To establish the criteria in Paragraph 26 above, requirements of local cooperation to cost share, to study, and to participate in pertinent developmental and control programs for full utilization, preservation and protection of project and associated features, will be needed for the St. Petersburg Reservoir Project. The project would be essentially constructed, maintained and operated by the Corps of Engineers, with appropriate division of project developmental responsibilities distributed among other local, State and Federal agencies depending upon finalization by pre-construction studies of cost allocations for which predetermined, firm agreements are needed.

Consequently, prior to construction of the St. Petersburg Project, suitable assurances and agreements should be obtained from appropriate local and State interests, that they will:

(1) Hold and save the United States free from damages resulting from water-rights claims due to construction and operation of the project;

(2) Exercise to the full extent of their legal capability, control against removal of streamflow made available for water quality control;

(3) Contribute to the control of pollution of streams subject to low-flow augmentation by adequate treatment or other methods of controlling wastes at their source;

(4) Within statutory limits, adopt and enforce flood plain management regulations to guide future developments within the flood plain away from locations which are threatened by flood hazards to minimize future flood damages;

(5) In accordance with the Federal Water Project Recreation Act of 1965, PL 89-72:

Administer project lands, facilities and water areas for recreation including fish and wildlife enhancement and assure access to such development to all on equal terms;

Pay, contribute in kind, or repay (which may be through user fees) with interest, no less than one-half of the separable first costs allocated to recreation, this one-half presently estimated at $13,900,000;

Bear all costs of operation, maintenance and replacements of fish and wildlife and recreation use lands and facilities, presently estimated at $590,000 annually. The Commonwealth of Pennsylvania, has indicated the State's intent to provide continued cooperation for the St. Petersburg Project. Suggestions by the Commonwealth relate specifically to acceleration of an acid drainage abatement program and for reconsideration during advanced planning of cost-sharing in the recreational facilities. This letter is included as Exhibit 11-6.

28. FEDERAL AGENCIES

As appropriate, during concurrent stages of planning, studies referred to in the preceding report sections as investigated and reported on by the Federal Departments of Agriculture; Commerce; Interior; and Health, Education and Welfare; the Federal Power Commission, and the Appalachian Regional Commission were coordinated under the Water Resource Survey for Appalachia by the Pittsburgh District of the Corps of Engineers and the Water Development Coordinating Committee for Appalachia (WDCCA).

Many of the representative Federal agencies charged with data accumulation and dissemination - mainly in this study the U.S. Geological Survey, the U.S. Bureau of Mines, and the U.S. Office of Business Economics - provided basic resources and statistical data for project planning, relevant to such as surface characteristics of the water resource related to climatology and streamflow, the groundwater resources, the mineral resources, and past and projected economic records, through their regular publications or special reports. Other Federal agencies participated also by furnishing data and reports by which the state and local agencies and planning groups were assisted in engaging in some specialized part of the project study.

Several agencies of the Departments involved made special basin and regional studies for the Survey to aid in formulation and evaluation of the St. Petersburg Reservoir and National Wild and Scenic river system aspects of the plan of development for the Clarion River. Reports of the investigations of these agencies on relevant topics of study are included in the appropriate Departmental appendices to the Main Report. The following paragraphs present study recommendations or views of participating agencies stemming from their studies, and actions taken by the Corps of Engineers thereon.

Bureau of Outdoor Recreation - BOR surveyed the eight-county recreation mark area surrounding the project and determined the water-oriented demand in that area (and beyond) for general recreation opportunities, present and future, which presently exceed the satisfaction capabilities of existing public and private recreation developments and scenic and natural recreation assets of the Clarion River in the project area. A framework of a recreational plan was formulated in cooperation with BOR by the Corps of Engineers in selection of eight initial recreational sites adjacent to the reservoir, and in the analysis of reservoir height and drawdown on the value of the recreation experience. The Corps of Engineers allocated the reservoir storage between the most suitable topographic elevations to limit the seasonal reservoir drawdown to the best suited elevation range for enhancement of the recreation benefits of the project. Consideration was recommended and given for preservation of canoeing and other values of the Clarion River in connection with a potential designation of the river as an addition to the National Wild and Scenic River System. The Clarion River Corridor involved in the recreation plan is

introduced to link the reservoir to Cook Forest State Park as an integral recreational river feature in the project plan. It has been further indicated that the Bureau will carefully evaluate all aspects of the proposed St. Petersburg project during the course of their detailed study of the Clarion River under the Wild and Scenic Rivers Act, PL 90-542.

Fish and Wildlife Service - The Bureau of Sports Fisheries and Wildlife of the F&WS studied the Clarion river in the project impoundment area and also in the area from the head of the impoundment to Ridgway, Pennsylvania, to cover the extent of the potential scenic river reach, to evaluate the fishing and hunting values afforded by the river and its tributary areas. The Bureau recommended primarily that a prerequisite condition be the abatement of acid mine drainage and reclamation of strip mines to develop wildlife habitat in the river basin, and installation of requisite fishing and hunting facilities and licensing of selected project lands above full pool level in a cooperative arrangement and under joint study, development and supervision with the Pennsylvania Fish and Game Commissions. Mitigation lands of 10,550 acres1/ and other lands were also recommended by the Bureau to offset losses of habitat and visitation in the Clarion River because of reservoir impoundment, and to practice wildlife management. The project plan provides suitable lands and facilities in which later cooperative efforts can be made as suggested to offset these losses on a cooperative basis with F&WS and the state fish and game commissions. Other Bureau recommendations relative to multiple level intakes in the dam control structure, and fishing piers access, parking accomodations, etc., are also provided in the plan. Facilities for enjoyment of fishing and hunting potential in the area above the impoundment to Ridgway are recognized for inclusion either in the overall recreation plan or in possible scenic river development of the river to Ridgway by the U.S. Forest Service and/or BOR, under coordinated state development and supervision.

Federal Water Pollution Control Administration - FWPCA in cooperation with the Pennsylvania Department of Health investigated water supply and water quality conditions in the Clarion River and concluded therefrom: that the Clarion, Pennsylvania, area needed a source of future water supply; that based on water quality sampling and inventory of pollution sources, principally abandoned acid producing coal mines, water in the Clarion River would be marginal for development of water based recreation in the project impoundment, unless preceded by program of abatement and reclamation; and that water quality control needs of the Ohio River at Sewickley, Pennsylvania downstream from Pittsburgh, indicated necessity for additional reservoir storage for low-flow augmentation. This storage is provided in St. Petersburg Reservoir.

1/ It is recommended that up to 10,550 acres to mitigate wildlife losses be authorized. During advanced engineering and design, the economic feasibility of the recommended mitigation measures will be reevaluated and the extent of the mitigation unit established accordingly.

Federal Power Commission - The Federal Power Commission, through its New York Regional Office, prepared power evaluations and potential conventional and pumped-storage power facility developments and sizing. Power studies herein were coordinated with the Regional Office, and the most feasible power developmental plan, generating capacity and power production were mutually agreed upon.

Housing and Urban Development and Economic Development Administration - The Department of Housing and Urban Development and the Economic Development Administration, Department of Commerce, cooperated by furnishing basic economic data and reports for use in preparation of the economic development plan for the project.

Bureau of Mines - The BOM inventoried the mineral resources, coal, gas, and oil, of the project and scenic river area in connection with the project study. Reserves of strippable coal are evaluated, and the numbers of oil and gas wells estimated, upon which BOM concludes: that in the project area the impoundment will somewhat adversely affect gas and oil extraction, but that the bulk of these mineral resources can be utilized under a permissive but controlled extraction program; that no mineral resources would be expected to exist in the river area upstream from the impoundment. These are recognized in the plan development.

National Park Service - The objectives of the National Park Service are:

(a) Preservation and enhancement of areas of unique scenic, archeological, historic, and natural science values.

(b) Improvement of land and water quality management.

(c) Consideration of structural and non-structural measures, beneficial flow regulation, and flow regulation storage.

In addition to the above; Public Law 89-665, the National Historic Preservation Act of 1966 requires that any Federal or Federally assisted undertaking in any state take into account its effect on any historic site or structure listed in the National Register of Historic Places. The National Register of Historic Places is a list of properties significant to the nation, to the states, and to local areas because of significance in history, architecture, archaeology, and culture.

Studies by the National Park Service to carry out these objectives will be requested by, and coordinated with the appropriate office having responsibility for construction of this project. These studies will be requested when advanced engineering and design for the project is initiated.

The NPS through the Clarion State College Archaeological Department investigated the project and scenic river areas for archaeological and historical site values and artifacts for preservation and study. It was recommended that future studies and excavations are warranted to better identify these sites and to make a more complete inventory so that three or more iron furnaces and numerous Indian Rock Caves and certain prehistoric indications can be preserved and salvaged. The estimated cost for doing this investigation is included as a project cost, and will be funded and studied by National Park Service during advanced planning, but preservation of the historical sites, etc., which are outside of the project development area, are not presently considered as an appropriate project cost.

Soil Conservation Service - SCS study of the West Branch of the Clarion River for upstream watershed developments and land treatment measures recommends that these would furnish water supply and recreation to this upper basin area. Control of this area, although relatively small, may benefit the scenic river area above the project as a part of the multiple -purpose development of the Clarion River Basin. The Corps of Engineers concurs in this recommendation.

Forest Service - The USFS although it is not materially involved in the project area has informally coordinated relative to its recreation potential in Allegheny National Forest areas contiguous to the Clarion River above the project area. In view of the location of the Allegheny National Forest relative to project location the FS has made no specific recommendation relative to the immediate project area. However, the U.S. Forest Service is cooperating in a task force with the Bureau of Outdoor Recreation to study the potential of the Clarion River from Ridgway to its mouth, to determine if the river has sufficient merit to be recommended for possible inclusion in the National Wild and Scenic Rivers System.

29. STATE AGENCIES

The Commonwealth of Pennsylvania has many agencies and departments which assisted liberally in the study and report by coordinating information and data, and by participating in the water quality and environmental study of the Clarion River. In one manner or another the Departments of Forests and Water, Mines and Mineral Industries, Commerce, Highways, Health, Game and Fish Commissions, and the State Planning Board of the Governor's Office, all contributed to development of the project plan.

Further, the Commonwealth's letter (Exhibit 11-6) provides a firm basis for continuation of coordinated Federal and State efforts in both the pre- and post- authorization stages. Such future work will undoubtedly provide the better definition of the program for pollution abatement which the Commonwealth desires.

30. LOCAL GROUPS

The contiguous State Local Development Districts, the County Planning Commissions, the CROWD Organization, and Clarion State College furnished valuable data and information for plan development.

The local groups in attendance at the public hearing of 18 June 1968 in majority endorsed the project activity and enthusiastically. Their intense interest predominates the entire evolvement of the project plan.

31. PUBLIC HEARING

A public hearing was held by the District Engineer at Knox, Pennsylvania, on 18 June 1968 for the purpose of considering specifically the potential St. Petersburg Dam and Reservoir project in relation to a plan of water resources in Sub-region F, and to afford interested parties an opportunity to express their views on each. A total of 275 persons were present at the hearing, including representatives of Federal, State and local governing bodies, representatives of commercial, industrial and public utility firms, highways and railroads, and interested private citizens resident in and adjacent to the project area and the sub-region. The great majority of statements were in favor and only a few in opposition to construction of the potential St. Petersburg project, the only major reservoir proposed for Ohio River Basin portion of Sub-region F. Few property owners affected by the potential project expressed opposition toward the project. No Congressional representation was in attendance.

Favorable considerations concerning the project were expressed by a broad cross-section of those attending the hearing. Emphasis is placed on testimony of the Secretary of Forests and Waters of the Commonwealth of Pennsylvania, the Governor's representative, on the need for major project development in the Eastern part of the United States, a lack of reservoir storage capacity and a massive pollution problem in his submission for the record of his statement at the Denver Water Resources Conference, 16-20 May 1966, and his testimony in support of construction of the project if assured of effective pollution abatement measures before or during project construction. The latter need was confirmed by testimony of the Pennsylvania Department of Health, and statements by FWPCA and USDA.

The record of the public hearing is officially documented by the Pittsburgh District of the Corps of Engineers.

32. PROCEDURES FOR PLAN IMPLEMENTATION

A plan for multiple-purpose development for the Clarion River as formulated herein relative to water and related resources at the St. Petersburg project, and what may be evaluated to be compatibly associated potential upstream wild and scenic river opportunities, will either individually - or by joint planning and implementation - involve participation in construction features and developmental opportunities of at least three governmental construction agencies and several governmental agencies who will be devoted to preparing detailed studies to support a broad program of basin improvements. Assuming that local and state assurances are forthcoming, and satisfactory, and that any Federal constraints to authorization and construction, and full project and basin development consistent with the multiple-purpose basin objectives are removed, the best foreseeable procedure for implementing the overall plan is outlined below.

The Corps of Engineers will assume overall responsibility for coordinating and implementing the reservoir project component including a scenic corridor to Cook Forest State Park, and, if desired by the U.S. Forest Service and BOR, will jointly enter into a task force arrangement with these Departments to lead toward scenic preservation and development of the Clarion River from the project's scenic corridor into and up through a scenic river situation for the entire reach to Ridgway, Pennsylvania. For purposes of successfully implementing the reservoir project, the approach can be rationalized into a series of individual yet integrated basic parts extending from about the mouth of the Clarion River upstream through the project scenic corridor in accordance with the following sequence:

a. Acquisition of land for the entire reservoir plan; and concurrently,

b. Abatement of pollution and reclamation of strip-mined zones in the project area;

c. Construction of St. Petersburg Dam and Reservoir, exclusive of complete general recreation development, by the Corps of Engineers; and concurrently,

d. Conversion of reclaimed areas to general recreation areas where applicable, or aesthetic improvement areas where not to be used initially for general recreation; and consecutively and/or concurrently,

e. Construction and development of general recreation facilities and consecutively and/or concurrently,

f. Construction of hydroelectric power generation and distribution facilities (Federal or non-Federal development), and

g. Operation and maintenance of the constructed works; and simultaneously with items b through g,

h. Investigation of a strategy of ecosystem development for the project area, monitoring of water quality improvements, and determination of best system of reservoir level regulation.

The Corps of Engineers would acquire all lands necessary for the reservoir plan which are not now in public ownership. Consideration of land acquisition with the Commonwealth of Pennsylvania and other Federal Departments, or local interests desiring to sponsor public, quasi-public and private developments, will be determined after study of economic development opportunities and the necessity for timely initiation of such improvements and a strategy of successive developments to realize overall project objectives. The Corps will construct St. Petersburg Dam and Reservoir including all initial recreation facilities around the reservoir to early accommodate relatively maximum visitation expected. Operation and maintenance of the main project features and facilities and those for distributing project information and guidance, safety and sanitary comfort of visitors will be the responsibility of the Corps except for the recreation facilities.

A master plan for recreation development of St. Petersburg and for economic development of the project area of influence will be perfected with the Commonwealth of Pennsylvania and with other Federal agencies, as appropriate, to insure orderly development of the reservoir and associated areas. The Commonwealth will construct additional recreation facilities as visitation trends continue to indicate need for implementation of private developments to supplement general recreation facilities and will operate and maintain the initial facilities as well as those they will construct after project completion.

The Commonwealth of Pennsylvania through its appropriate resources agencies and fish and game commissions, with coordination and cooperation of the corps of Engineers and the bureau of Sport Fisheries and Wildlife, will institute and maintain fish and wildlife management practices conducive to optimum project development. Implementation of habitat improvement measures and operation and maintenance of this program will be the responsibility of the Commonwealth.

33. CONCLUSION

The management of the stream flow of the Clarion River to alleviate flood damages, to provide good quality water for water supply and water quality control, to provide water-based recreation opportunities, which could also enhance the scenic attributes of the river, and to provide the products of related land and water management is required to sustain

and enhance the economic well-being in Sub-region F as well as portions of the Ohio River Basin and other areas outside the sub-region. The plan of development in the Clarion River area below Cook Forest State Park as developed in this chapter has taken note of foreseeable water resource needs and trends and has produced as many solutions to those as appear at this time to be economically feasible. This development is a nucleus for other allied developments in the sub-region and is only one element in the total water resources plan for both the Appalachian Region and the Ohio River Basin. The project is an essential element also for the total plan of water and related resources envisioned by the Ohio River Basin Comprehensive Review Survey.

The development of the Clarion River consists essentially of construction of a multiple-purpose reservoir project. This is estimated to have a total construction cost of $240 million dollars. This is equivalent to an annual value of $12.2 million dollars which includes costs for maintenance and operation. It is estimated that this investment will create an associated investment of approximately $591 million dollars. Benefits for the objective of increasing national income are estimated at approximately $21.6 million dollars annually. Benefits that would have regional impact are estimated to be $19.8 million dollars annually.

Implementation of the plan for development of the Clarion River as outlined in this chapter will require the joint efforts of the U.S. Army, Corps of Engineers, the U.S. Forest Service, the U.S. Bureau of Outdoor Recreation and the Commonwealth of Pennsylvania. In the advanced planning process these agencies will need the help of several other Federal agencies including the National Park Service, Federal Water Pollution Control Administration, Bureau of Mines, and the Fish and Wildlife Service.

The Commonwealth of Pennsylvania has reviewed the proposed plan of development and is generally in agreement with it. The views of the Commonwealth are attached in Exhibit 11-6.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
HARRISBURG
17120

THE SECRETARY

In reply refer to
WCE
F 69:6

P. O. Box 1467

September 30, 1969

Col. Wayne S. Nichols
District Engineer
U. S. Army Engineer District, Pittsburgh
Corps of Engineers
Federal Building - 1000 Liberty Avenue
Pittsburgh, Pennsylvania 15222

Dear Colonel Nichols:

I have had the opportunity to review the Draft Report on the proposed St. Petersburg Reservoir Project in Clarion, Jefferson and Forest Counties, Pennsylvania. The St. Petersburg Project has been developed by your office as part of the Water Resources Study of the Appalachian Region in Pennsylvania.

In reviewing the report, I note that the project will have a significant effect on the water resources of Pennsylvania. The project as designed will provide flood control, water supply, water quality, recreation, fish and wildlife, power and economic development benefits.

Under Section 206 of the Appalachian Regional Development Act of 1965, the Secretary of the Army was " xx authorized and directed to prepare a comprehensive plan for the development and efficient utilization of water and related resources of the Appalachian Region, giving special attention to the need for an increase in the production of economic goods and services within the Region as a means of expanding economic opportunities and thus enhancing the welfare of its people". xx. The Act requires that the plan be submitted to the Appalachian Regional Commission for transmittal with a statement of its views to the President who will submit the report with his recommendations to Congress.

As part of the comprehensive plan for the development and efficient utilization of water and related land resources of the Appalachian Region, the Commonwealth of Pennsylvania

made certain studies and submitted to the Office of Appalachian Studies, Corps of Engineers, the Pennsylvania State Supplement. The Pennsylvania State Water Resources Supplement was intended to be a supplement to the U. S. Army Corps of Engineers "Report for Development of Water Resources in Appalachia".

As one of the recommendations contained in the Pennsylvania State Supplement, we recommended that further study be made of the construction of a multiple purpose reservoir proposed by the U. S. Army - Corps of Engineers on the Clarion River near St. Petersburg. In addition, we requested that consideration be given to the total impact and effect of this reservoir on the water and related land resources of Pennsylvania.

In reviewing the draft of the report on the St. Petersburg Reservoir Project, I note that considerable studies have been made concerning the effects of the St. Petersburg site on the water and related land resources of Pennsylvania. The project as envisioned will provide numerous recreational areas around the periphery of the reservoir, wildlife management areas and the Clarion Corridor which would extend from Clarion upstream to Cook Forest State Park. The inclusion of the Clarion Corridor, as well as the recreation, wildlife and other similar areas indicates that a considerable amount of environmental planning has been incorporated into the project developed by the Corps of Engineers.

As one of the integral parts of the program developed, we feel that mine drainage abatement work in the Clarion River is extremely important. Mine drainage abatement work was included as one of the recommended projects in the Pennsylvania State Supplement. It should be noted that, at the present time, there is a disagreement on the extent of pollution abatement measures necessary in the Clarion River Basin in order to upgrade water quality to the point where it will be satisfactory for recreational uses. It would appear to me that additional studies are required in this matter in order to reach

an agreement on the extent and cost of pollution abatement measures needed in order to improve water quality. As in the past, the various Commonwealth agencies will be pleased to work with your office in a revaluation of the pollution abatement costs.

The St. Petersburg Project was developed as part of the water and related land resources comprehensive plan for the Appalachian Region. We feel that the St. Petersburg Project will meet the test for development and efficient utilization of water and related resources of the Appalachian Region. Certainly such a project would provide for the increase in production of the economic goods and services within the region, as a means of expanding the economic opportunities and thus enhancing the welfare of the people residing in Appalachia. Under any program developed for the St. Petersburg site, recreation will be one of the most important factors.

The effects of construction of the St. Petersburg Project will be widespread and National in scope. The basin is centrally located with regard to the tremendous industrial complex which encompasses large urban areas in West Virginia, Ohio, New York, and Pennsylvania. With the completion of the Interstate Highway system, the reservoir will be located within easy driving distances of the large metropolitan areas of Cleveland, Akron, Canton, Youngstown, Wheeling, Pittsburgh, Johnstown, Erie and Buffalo. In view of the fact that the recreation facilities to be provided at the project will be National in scope, we feel that the provisions of P. L. 89-72, Federal Water Protection Recreation Act of 1965, are not applicable to the St. Petersburg site. Consequently, the proposed allocation for cost-sharing in the recreation facilities should be reconsidered.

Under the Act of January 19, 1968, the Commonwealth of Pennsylvania approved "The Land and Water Conservation and Reclamation Act". This Act provides funds to the Pennsylvania Department of Mines and Mineral Industries for the

prevention, control and elimination of stream pollution from mine drainage. Under this program, it is expected that funds will be furnished for pollution abatement work in the Clarion River Basin. This fact illustrates the point that the Commonwealth is attempting to solve its water resources problems. Unfortunately, sufficient funds are not available to do all required pollution abatement work in Pennsylvania. Federal financial assistance is urgently needed in order to accelerate this program. The mine drainage abatement work in the Clarion River Basin is necessary in order to enhance the environment of the area and improve water quality, not only in Pennsylvania but in Ohio and West Virginia. We are hopeful that Federal financial assistance in this endeavor will be forthcoming in the immediate future.

Your courtesy in furnishing a copy of the report of the St. Petersburg Project for our review is very much appreciated. We will continue to cooperate with your office in future planning for the project.

Sincerely yours,

Maurice K. Goddard

MAURICE K. GODDARD

Sheet 4 of 4
Exhibit 11-6

REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSES
CHAPTER 12
GREENBRIER PROJECTS

Office of Appalachian Studies
Corps of Engineers
October, 1969

PART III
PROJECT ANALYSES
CHAPTER 12 - GREENBRIER PROJECTS

A selected early action plan for the Greenbrier Basin included two Corps lakes - Greenbrier Lake (upper), Site 87, and Anthony (Creek) Lake, Site 40. Chapter 12 of Part III to the Main Report was to describe this plan as it was formulated.

Subsequent to formulation of the interim sub-basin plan, a Natural Streams Preservation Act was enacted by the Legislature of West Virginia which designated as protected streams, among others, all of Anthony Creek and the portion of Greenbrier River from the mouth to its confluence with Knapp Creek. The Act prohibits work that will materially alter or affect the free-flowing characteristics of a substantial part of protected streams. Responsiveness to legislative policy and intent, as expressed in the Act, precluded further consideration of Site 40 on Anthony Creek.

A meeting of the Kanawha Basin Survey Coordinating Committee was held in June 1969 to select the tentative plan for development of the water resources for the Basin. The Committee directed retention of Site 87 on Greenbrier River for consideration as an alternate for other sites that were proposed.

The interim plan for the Greenbrier sub-basin that was prepared for issuance as Chapter 12, Part III, of this report, will therefore not be published.

REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSES

CHAPTER 13

LOWER KNOX CREEK RESERVOIR PROJECT
(TUG FORK BASIN)

KENTUCKY, VIRGINIA AND WEST VIRGINIA

Office of Appalachian Studies

Corps of Engineers

October 1969

PART III

PROJECT ANALYSES

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PART III

PROJECT ANALYSES

CHAPTER 13 - LOWER KNOX CREEK RESERVOIR (TUG FORK BASIN)

SECTION I - SUMMARY

1. PHYSICAL DESCRIPTION

Basin Description

The Tug Fork Basin is located in eastern Kentucky, southwestern West Virginia, and has 2 small segments in northwestern Virginia (See Exhibit 13-1). Tug Fork, the principal stream of the basin, is 155 miles long. The lower 95 miles forms the boundary between Kentucky and West Virginia, the next 5 miles are the boundary between West Virginia and Virginia, and the remaining 55 headwater miles are in West Virginia. The basin is in Lawrence, Martin and Pike Counties, Kentucky; Wayne, Mingo, and McDowell Counties, West Virginia; and Buchanan and Tazewell Counties, Virginia. Williamson, West Virginia, is the largest city in the basin and is the principal industrial, transportation, and trading center.

The area of Tug Fork Basin is 1,555 square miles. Its length is about 120 miles and the average width is about 20 miles. Its long axis lies in a northwest-southeast direction. Tug Fork rises in McDowell County, West Virginia and flows northwest to Louisa, Kentucky, and Fort Gay, West Virginia, where it joins the Levisa Fork to form the Big Sandy River. That river continues to flow northerly 27 miles further to join the Ohio River downstream from Huntington, West Virginia.

The Basin lies in the Appalachian Plateau. The topography is rugged, sharply dissected with a total relief of over 3,000 feet. The basin streams flow in deep, narrow, sinous valleys between steep sided ridges. Level lands suitable for industrial, commercial and residential development comprise an extremely small portion of the Basin. The level lands that are available are found along the stream channels and to a more limited extent along the ridge lines.

Project Description

The water resources project that has been endorsed by local interests as being of vital significance to the economy is a reservoir on the lower reaches of Knox Creek. That project was selected for detailed analysis because of this interest and because it is one of the more feasible projects that might contribute to the regional economy.

The proposed Lower Knox Creek multiple-purpose reservoir project would be located principally in Pike County, Kentucky, and extend into Buchanan County, Virginia. The dam would be situated about 14 air miles southeast of Williamson, West Virginia, and 0.4 mile upstream from the confluence of Knox Creek with Tug Fork. It would control 113 square miles of drainage area in the upper middle portion of the Tug Fork Basin. The location is shown on exhibit No. 13-1.

Major physical features of the project would be the 228-foot high, rockfill dam having a crest length of 980 feet and a top width of 32 feet; a 250-foot wide, uncontrolled spillway; and eight associated recreation areas with appropriate facilities located on or near the 220 acre lake formed by the water quality control pool.

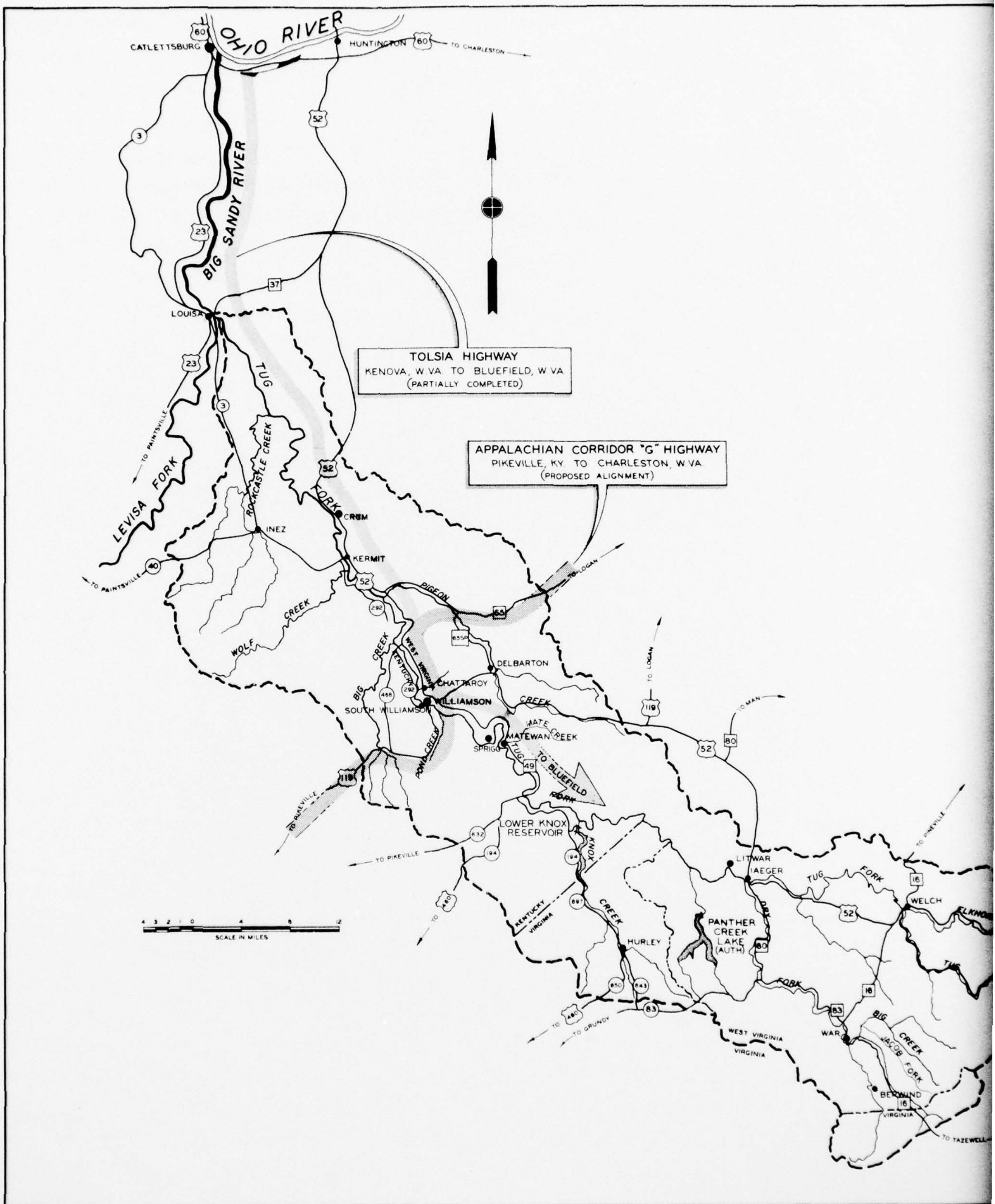
2. PROJECT IMPACTS

The Lower Knox Creek Project has been planned to provide services needed to aid in satisfying needs of the area and thereby encourage development of the Tug Fork Basin. Specific benefits to be realized from this project would be:

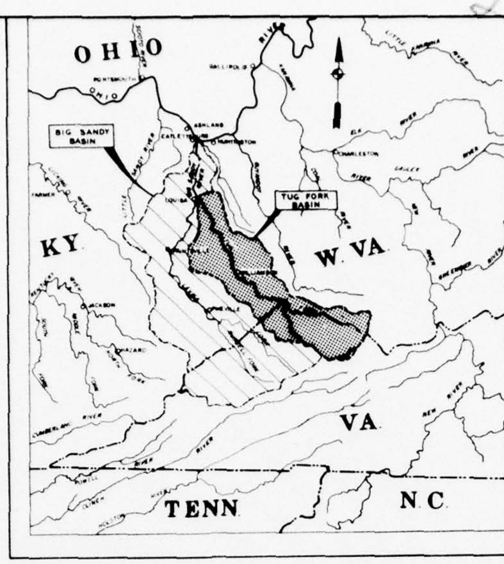
a. Flood damage reduction
b. Water quality control
c. Fish and wildlife enhancement
d. Outdoor recreation
e. Redevelopment

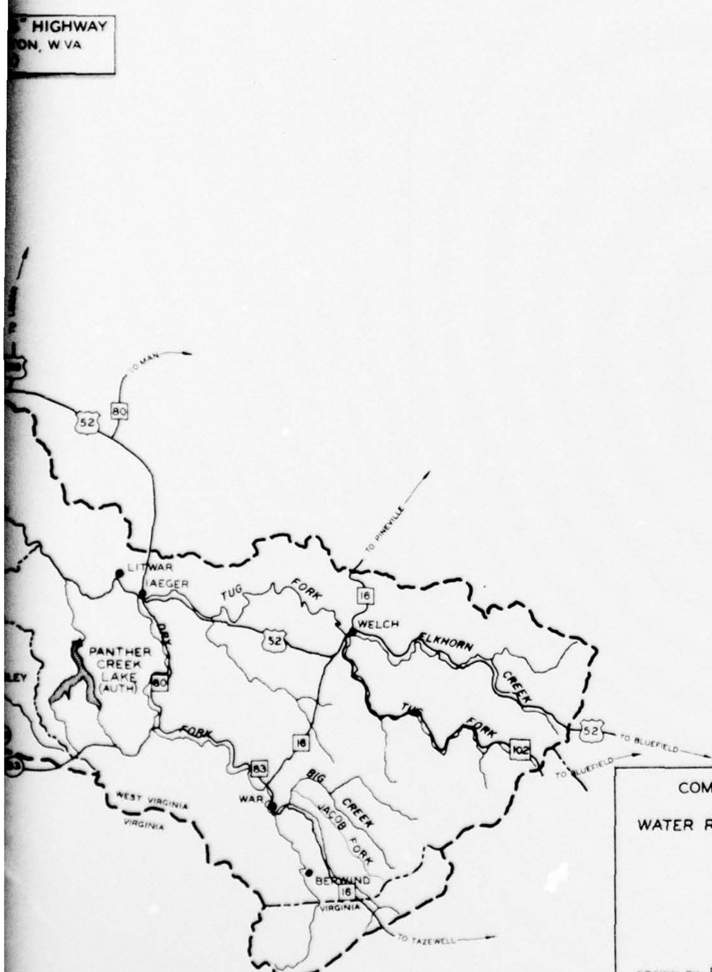
The Lower Knox Creek project, operating in conjunction with the Panther Creek Reservoir, would reduce flood hazard along Tug Fork throughout its length and have some effect along the Big Sandy and Ohio Rivers. About 11 percent (6,020 acre-feet) would be utilized to improve the quality of flows along Tug Fork and the Big Sandy River. Fishing enhancement would be supplied for some 3,700 fishermen annually through the provision of a controlled, stocked reservoir and through supporting facilities and access points around and below the reservoir. Limited hunting (for 4,000 hunters) would occur and would be permitted where consistent with safety of other recreationists. General outdoor recreation, although severely restricted by topography and railroad relocations, would provide opportunities for about 100,000 visitors annually. Economic development of the area of influence would be supported by additional job opportunities both during and after construction.

There are several dominantly significant factors which have pervasive influence upon the Tug Fork area, factors which may well override the traditional criteria for economic analysis: a. The valley offers now and will continue to offer jobs in the coal and associated industries since about 11% of all bituminous coal mined nationally flows out of the general area; b. To be acceptably near their work, the people



OHIO RIVER
CATLETTSBURG
HUNTINGTON
TO CHARLESTON
BIG SANDY RIVER
LOUISA
TUG
TOLSIA HIGHWAY
KENOVA, W.VA. TO BLUEFIELD, W.VA.
(PARTIALLY COMPLETED)
APPALACHIAN CORRIDOR "G" HIGHWAY
PIKEVILLE, KY. TO CHARLESTON, W.VA.
(PROPOSED ALIGNMENT)
LEVISA FORK
TO PAINTSVILLE
ROCKCASTLE CREEK
FORK
CRUM
INEZ
KERMIT
PIGEON
TO LOGAN
WOLF CREEK
BIG CREEK
DELBARTON
CHATTAROY
WILLIAMSON
SOUTH WILLIAMSON
CREEK
MATEWAN
MATE CREEK
SPRIGG
TUG
TO BLUEFIELD
FORK
POND CREEK
TO PIKEVILLE
TO MAN
LOWER KNOX RESERVOIR
KNOX
CREEK
KENTUCKY
VIRGINIA
HURLEY
PANTHER CREEK LAKE (AUTH)
LITWAR
IAEGER
TUG FORK
WELCH
ELKHORN
DRY
FORK
WAR
BIG CREEK
JACOB FORK
BERWIND
VIRGINIA
TO TAZEWELL
WEST VIRGINIA
VIRGINIA
TO GRUNDY
SCALE IN MILES





COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

TUG FORK BASIN

SCALE: AS SHOWN

DRAWN BY: RLK & CLF APPROVED: ______
TITLE: ______
CHECKED BY: ______ DATE: ______

EXHIBIT 13-1

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must use every reasonably level piece of ground for dwellings and businesses; c. The past fourteen years have brought damaging floods to these dwellings and businesses with a distressing regularity; and d. Given even moderate flood protection, as at Williamson, the people can be expected to react quickly and tellingly to rebuild and institute warning and flood plain management measures.

Using normal criteria, the Lower Knox project cannot be justified now or, perhaps, ever. However, the Tug Fork does not present a normal situation. In the Tug Fork, we have a people apparently consigned immutably to a second class existence because of the hazards and financial disasters of flooding. Their alternative is to leave the Tug Fork Basin which entails the loss to the National economy of the valuable contributions made by the valley. Continuance of the present conditions probably will result in this alternative being forced upon them. Yet, even moderate flood protection could dramatically alter the future of the Tug Fork for the better.

3. COSTS AND BENEFITS

Initial construction costs for the Lower Knox Creek Reservoir are estimated to be $49,200,000, with the annual economic charges estimated at $1,891,000. Comparable values for associated private investments are $872,000 with an annual equivalent of $44,000. Annual benefits estimated for Lower Knox Reservoir are as follows:

	BENEFITS	
	National	Regional
User	$ 960,700	$ 866,700
Expansion effects		
Redevelopment	148,400	283,500
Development	84,000	337,000

The index of performance for the objective of increasing national income would be 0.6 and for increasing regional employment 0.3. (See Section VI.)

4. COOPERATION REQUIRED FOR CONSTRUCTION

Since the flood control and water quality control benefits of the Lower Knox Creek project are considered widespread, the costs allocated to these purposes would be apportioned to the Federal Government. Public Law 89-72, "Federal Water Project Recreation Act," provides for a substantial level of Federal participation in the cost of development for general recreation and fish and wildlife enhancement. However, non-Federal interests must agree to administer project land and water

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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)

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areas for these purposes, bear not less than one-half of the separable costs allocated thereto, and bear all the costs of operation, maintenance and replacement of general recreation and fish and wildlife facilities. Because the project is considered infeasible under criteria believed applicable, such assurances have not been formally requested.

Exhibits 13-13, 13-14 and 13-15 (pages 109 to 111) are staff responses from Kentucky, West Virginia and Virginia. The states recognize the local interest in the project and indicate a willingness to explore an interstate arrangement to handle the recreation.

5. TUG FORK BASIN - EXISTING CONDITIONS

General

The Tug Fork Basin is located in one of the world's most important areas of bituminous coal production. For more than 50 years, the economy of the area has been integrally related to the mining, preparation, and distribution of coal. About 40 percent of the basin's employment is directly related to the mining and rail industries. Most of the remaining employment is in trades and services that are indirectly dependent on coal production. This economic dominance by one resource-extractive industry is likely to continue. Reserves of high-quality, commercially-exploitable coal are sufficient to permit production at the present rate to be continued for several hundred years and the demand for coal is expected to remain indefinitely at its current or a higher level.

Although coal has been, and still is, the basic element in the regional economy, decreasing markets for coal since the 1920's and changing mining practices have contributed to the problems of development. The chronically depressed conditions in the area are related to long-evolving changes in patterns of coal production and consumption. High rates of unemployment and out-migration that persistently plague the area are attributed largely to erosion of the coal market by competitive sources of energy, to technological improvements that have reduced need for non-skilled and semi-skilled laborers in the mining activities, and to lack of economic diversification to buffer the cyclical operational characteristics of the coal industry.

Mining activity has resulted in establishment of mining and coal preparation facilities and small communities along the Tug Fork and all major tributary systems in a randomly dispersed pattern. The main line of the Norfolk and Western Railroad is located along the Tug Fork and branch or spur lines extend along almost all the tributary streams to collect and transport the coal to its markets. Most valleys also have roads to serve the communities. The rugged terrain necessitates that improvements be located in the narrow flood plain because of the difficulty and expense of constructing on the steep hillsides. Communities are thin and somewhat elongated along the valley floor because the width will permit only a limited concentration of residences or commercial establishments in addition to the road, railroad, and stream channel.

Transportation

The basin is served by U.S. Highways 52 and 119 and by several state and local highways. U.S. 52 traverses the basin in a northwest-

southeast direction while U.S. 119 crosses the basin in a northeast-southwest direction. The rugged topography has been unfavorable for the construction of an adequate network of roads.

The main line of the Norfolk and Western Railroad enters the basin at the extreme headwaters of Elkhorn Creek and follows Tug Fork for nearly its entire length to leave the basin where, with Levisa Fork, the Big Sandy River is formed. Branch lines run up most Tug Fork tributaries to serve coal mining operations.

The Tolsia Highway, a portion of which is under construction and partially completed is planned to run eventually from Kenova to Ft. Gay on the Big Sandy and then up the Tug Fork to Williamson. The Appalachian network system of highways has established a corridor through the basin, in a north-south direction, thence via U. S. Route 52 to Bluefield and would pass through Williamson (See Exhibit 13-1).

Human Resource Development

The 1960 population of Tug Fork Basin (McDowell and Mingo Counties, West Virginia, and Pike and Martin Counties, Kentucky) was 189,600. Distribution of the population by location deviates considerably from the national norms. For the general region which is typical for Tug Fork, the rural non-farm category comprise 87 percent of the total population, while the urban and rural farm classifications amount to only 11 and 2 percent, respectively.

Settlements are widely dispersed, with small concentrations along flat narrow strips in the stream valleys. In 1960, there were 17 communities with population of over 1,000 in the basin and of these, 2 had population in excess of 5,000. All but one are in West Virginia. Table 13-1 lists the communities:

TABLE 13-1
COMMUNITIES IN TUG FORK BASIN WITH
POPULATION OVER 1000 IN 1960

Name of Town	County	Stream	1960 Population
Anawalt	McDowell	Little Creek	1,062
Caretta	McDowell	Barrenshe Creek	1,092
Coalwood	McDowell	Clear Fork	1,199
Davy	McDowell	Tug Fork	1,331
Delbarton	Mingo	Pigeon Creek and Rockhouse Fork	1,122
Eckman	McDowell	Elkhorn Creek	1,125
Gary	McDowell	Tug Fork	1,393
Keystone	McDowell	Elkhorn Creek	1,457
Kimball	McDowell	Elkhorn Creek	1,175
McDowell	McDowell	North Fork of Elkhorn Creek	1,109
Maybeury-Switchback	McDowell	Elkhorn Creek	1,423
Roderfield	McDowell	Tug Fork	1,020
South Williamson	Pike	Tug Fork	1,097
Thorpe	McDowell	Tug Fork	1,102
War	McDowell	War Creek & Dry Fork	3,006
Welch	McDowell	Tug Fork	5,313
Williamson	Mingo	Tug Fork	6,746

All of the above communities for which statistical data were available in 1950 and 1960 lost population during the decade. This loss in population is indicative of a trend of much longer duration.

The area was first settled around the time of the Revolutionary War but population remained relatively low until about 1900. At that time, coal mines and rail lines began to be developed and a large in-migration resulted. By 1920, the population reached a peak level and ceased to grow after that time. During recent years, considerable out-migration has occurred. A large portion of the migrants are young people. The area is characterized by high unemployment rates. Some skilled jobs are available as a result of increasing mechanization of mining operations. Most of the towns are elongated strips because of topographic conditions and are not efficient for provision of community services. In almost all communities, cultural and recreational facilities are inadequate and in some, much of the housing is inadequate. Also, the towns are too small to support adequate educational, health, commercial, and cultural facilities that are necessary to support a standard of living comparable to the rest of the nation.

Lands

The rugged nature of the basin lands has dominated the development and use of the land resource. A study of land slopes in McDowell County revealed that 93 percent of the county areas had slopes in excess of 40 percent. This condition is typical over most of the area. About 90 percent of the area is in forest cover, primarily hardwoods, with oak and yellow poplar predominant. The better timber has been harvested; relatively low-grade, second-growth trees remain. Less than 3 percent of the timber is publicly owned and relatively large portions of the holdings are in tracts of less than 5,000 acres. Harvest of timber in the area is presently only about one-third that which generally is considered desirable for best management practices. However, with the present oversupply of low-grade and small-size trees throughout the country and in the area, there is little likelihood of much increase in income from timber products. Agricultural development is limited to small isolated areas of marginal nature, with total use on the order of 3 percent of the land area. In Mingo County, 91 percent of the land is classified as undeveloped and of the developed area, almost one-third is devoted to open-space activities. There is an apparent maximum utilization of level lands. This intensity of use indicates a severe shortage of developable land.

Water Resources Development - Federal

Water resource development in the basin, both Federal and non-Federal, has been meager.

Corps of Engineers

The local flood protection project at Williamson, West Virginia, completed in 1963, protects the main business section of the town. The improvement consists of 2,135 lineal feet of concrete floodwall with 16 gate openings and a pump station. The project protects the city to a flood height equal to the maximum flood of record, that of 1963.

The Panther Creek Lake, authorized by the Flood Control Act of 1965, would be a multi-purpose reservoir for flood control, water quality control, recreation, and fish and wildlife enhancement. The reservoir site is on Panther Creek, a tributary of Tug Fork, in the upper portion of the basin (See Exhibit 13-1). The project would control drainage from an area of 23.6 square miles entirely within West Virginia. Reduction in stages of larger floods for the areas subject to major damage would range from 1 to 1.5 feet as a result of project operation. Storage for water quality control would be included to assist in providing flow augmentation needed on Tug Fork and Big Sandy River. Recreation and fish and wildlife facilities would be provided.

A small flood control project consisting of raising and improving a privately constructed levee around the Appalachian Regional Hospital at South Williamson, Kentucky, to increase the level of protection, has been approved under continuing authorities available to the Chief of Engineers. The approved project would give a high degree of protection to the Hospital. The project is scheduled for construction in Fiscal Year 1970.

Two small channel improvements to reduce local flood damages have been approved for construction on Rockcastle Creek and its tributaries, in the vicinity of Inez, Kentucky, and on Dry Fork in the vicinity of Berwind, West Virginia. Actual initiation of construction has been delayed awaiting completion by local interests of measures to meet legal requirements of non-Federal cooperation.

Department of Agriculture

The Soil Conservation Service has an approved watershed improvement plan for Mate Creek that will provide a substantial reduction in Mate Creek flood stages and very minor reductions in Tug Fork flooding.

Water Resources Development - Non-Federal

Local interests have constructed several municipal water systems utilizing surface streams, mines, and wells for water supply sources. Some of the larger communities are sewered and have waste treatment facilities. There are no impoundments in the basin with significant effects on water resources. Except for minor local channel and rectification improvements made in connection with highway improvements, there are no non-Federal flood-control projects in the basin.

6. SOCIO-ECONOMIC

Planning Devices

Since Tug Fork Basin is located in three states, a number of geographic diversions have been utilized in studying the socio-economic aspects of the area. These divisions do not conform to the basin boundaries but encompass areas of similar economic characteristics. Organizations actively engaged in planning within the area include the Tug Valley Chamber of Commerce, Southern West Virginia Economic development Corporation (comprising nine counties including McDowell and Mingo) and the Mingo County Planning Commission. The Big Sandy (State Planning Sub-region 33) and Fivco (State Planning Sub-region 34) Development Councils are also active in administration programs in the Kentucky counties bordering the Big Sandy River and Tug Fork.

The planning agencies examined the problems and deficiencies of the districts potentials for growth, identified growth centers and formulated programs for future growth. In addition to the studies of the local planning agencies, the Corps of Engineers contracted for an environmental study by the Columbus Laboratories of Battelle Memorial Institute of the 4 county area of Logan, McDowell, and Mingo Counties, West Virginia and Pike County, Kentucky. These counties are representative of conditions in the basin. The purpose of the study was to collect and analyze available, but widely diffused data and evaluate the direct and immediate effects of resources and services on the economic potential of the basin.

Economic Characteristics

Population of the four county Tug Fork Area in the Battelle report was 240,935 in 1960, a decrease of 1,115 from that of 1940. The trends toward urbanization in the area are in opposition to those experienced in the Nation or in Appalachia. Labor force participation rates are much lower in the area than for the Nation. The following tabulation compares the rates:

	1960 Labor Force Participation Rates, Percent	
Item	United States	Study Area
Total	54.8	37.9
Male	77.4	59.1
Female	34.5	15.7

Unemployment, both hidden and reported, is excessive and persistent within the study area. Average annual unemployment ranged from 3 to 4 times that for the Nation from 1960 to 1966, with reported totals varying from 12,919 in 1960 to 6,243 in 1966.

As may be expected income is low as compared to that of the Nation. One of the most disturbing aspects is that per capita income has declined in recent years while the national average has been increasing. The per capita income in the area was $1,279 in 1966, down from $1,301 in 1960 as compared to $2,940 and $2,215 for national values for the same years.

7. FUTURE GROWTH PATTERNS

Regional

The Office of Business Economics of the U.S. Department of Commerce prepared projections based on historical trends of the expected future levels of employment and population to the year 2020, of a 10-

county area, of similar economic characteristics, in Kentucky and West Virginia. The area includes the Tug Fork Basin Counties. Delineation of the area and detailed presentation of the projection data are in Appendix E. The projections were based on assumptions used for national projection and were a part of the study which made projections for all of Appalachia that would be consistent with those for the Nation. Employment and population are expected to continue to decline until 1980 under these projections; the trend will reverse and a slight increase is indicated for 2000 and 2020.

A study made for the combined Big Sandy, Guyandotte, and Little Sandy River Basins area as a part of the comprehensive study of the Ohio River Basin*/ included an analysis of the energy markets for coal and electricity and projections of other factors for 19 regions of the basin. Both aspects contribute data bearing on the potentialities of future development in Tug Fork Basin. For example, the value of the output of coal, based on constant-value dollars, was projected to increase from $336 million in 1960 to $680 million in 2010, or an increase of over 100 percent. Population was projected to decline from 464,000 in 1960 to 368,000 in 2010, a decrease of 96,600.

To reflect development potentials of the 10-county area under favorable economic stimulus, a set of goals, or developmental benchmarks, were assigned by the Office of Appalachian Studies. These benchmarks may be represented by estimates of projected population, employment, and income, assuming a reversal of migration trends to zero by 1980, and an increase of employment and income which would attain approximate values for the Nation by the year 2020. The developmental benchmarks result in projected increase in population and incremental increase in employment greater than the projections of the Office of Business Economics. The development benchmarks are also shown in Appendix E.

An appraisal of the long-range trends for a four-county area (Mingo and McDowell in West Virginia and Martin and Pike in Kentucky) has been made by disaggregation of data in the Preliminary Report on Economic Projections of the Water Resources Council. The data consist of economic estimates and projections made for the water resource planning areas of the nation (WRPA) by the Office of Business Economics, U.S. Department of Commerce (OBE) and the Economic Research Service of the Department of Agriculture (ERS). Table 13-2 shows that population and employment projections based on the OBE-ERS data will continue its historic decline but at a somewhat slower rate.

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*/ Projective Economic Study of the Ohio River Basin, Appendix B, Ohio River Basin Comprehensive Survey, U.S. Government Printing Office, August 1964.

TABLE 13-2

Tug Fork Basin (Mingo, McDowell, Martin & Pike Counties)
Actual and Projected Employment
by Industry, Labor Force, and Population
1960 to 2020

Industry	1960	1970	1980	1990	2000	2010	2020
Agriculture, forestry, fisheries	408	200	100	50	50	50	50
Mining	15271	13700	12400	11000	10000	8800	8000
Construction	1193	1100	1000	900	800	800	800
Manufacturing	(1856)	(2300)	(2400)	(2600)	(2800)	(3100)	(3500)
Food & kindred products	445	490	550	630	720	810	910
Lumber and furniture	754	610	440	320	230	170	120
Miscellaneous	657	1200	1410	1650	1850	2120	2470
Transportation, Communication, Utilities	2558	1900	1500	1200	800	600	400
Wholesale and Retail Trade	6248	6700	6700	6600	6500	6300	6000
Finance, Insurance, Real Estate	523	600	600	600	500	400	400
Personal and Business Services	7286	8600	9700	10200	10900	11200	11300
Government	1192	1300	1600	1800	1900	1900	1900
Total	36535	36400	36000	34950	34250	33150	32350
Labor Force	43000	41500	39800	37900	36500	34900	33700
Population	189600	170100	152500	134400	118900	104200	92400

Source: Office of Business Economics, Department of Commerce; Economic Research Service, U.S. Department of Agriculture; U.S. Army Engineers, Huntington District. Parentheses indicate non-add items.

Tug Fork Basin

The vast amount of reserves of high-quality coal and the associated mining and transportation facilities are the greatest physical assets in the basin. Scenic qualities and timber reserves are of greater future potential importance than they have been in the past. The existing managerial and skilled work force operating the mining and transportation facilities are foremost in the human resources of the basin. These resources are the key to successful future development of the basin. Adequate support of these assets requires raising the quality of the environment and a vigorous personal-service industry.

Recent indications are that the coal industry is stablizing. Long-term contracts are being effected for large tonnages of coal that assure firm markets and encourage capital investments in machinery that will require skilled manpower. Estimates of the work force engaged in mining in southern West Virginia in 1966 increased over the previous year for the first time in many years.

The area needs vigorous growth centers to provide bases for personal-services activities. The under-construction Appalachian Highway Corridor system with Corridor G crossing the basin through Williamson should provide impetus for growth at Williamson and for strip development along the corridor. Further, the Tolsia Highway projected for construction from Kenova through Williamson to Bluefield should provide additional favorable growth factors not only to Williamson but also to other areas. The highway extending eastward from Welch to Bluefield in the adjoining Kanawha River Basin also has relatively favorable characteristics for growth. Development along the corridors will necessarily be limited to a type that can adapt to the relatively small plots of land available for use.

Local planning agencies have recognized the needs for training to meet skilled manpower requirements, for urban renewal, for enhancing health and educational services, for additional highways, and for other facilities and personal services. Provisions for some of these items are already underway and others are being planned. Development goals set forth by the Southern West Virginia Economic Development Corporation and the planning district include three categories graded urgent, critical, and important. Goals related to development of water resources include establishment of adequate flood control which is considered urgent, reduction of water pollution which is considered critical, and expansion of tourism attractions which is considered important.

To assess the potential of industrial development along Tug Fork, a field and office survey was made of possible plant sites along the valley between Fort Gay and Sprigg, W. Va. Data were collected relating to accessibility to highway and railroad facilities, area of

sites, frequency of flooding, and effects on the sites of modification of flooding by three potential reservoirs. Acceptance of areas as "plant sites" with minimum qualifications such as inaccessibility to rail or to a good road, and with areas as small as 7 acres, resulted in a total of 33 potential sites with total area of 464 acres. There were 14 potential sites with total area of 110 acres that were accessible to rail. The largest of these was only 19 acres in extent. The largest potential site in the valley was of 59 acres, and it was inaccessible to rail facilities and would be served only by a medium-duty highway. This site was almost twice the size of the next largest site.

Analysis of flooding of the sites indicated the majority were not potentially subject to severe flood hazards. Eleven sites with total area of 187 acres and including the two largest sites were not inundated by floods of record. Eight additional sites with total area of 135 acres have a natural recurrence of flooding less frequently than once in one hundred years. There were 10 sites with total area of 86 acres or approximately 9 acres per site that would benefit most from flood height reduction. These sites have a natural frequency of flooding ranging from once in 2 years to once in 49 years. The authorized Panther Creek Reservoir would reduce flooding on these sites.

Summary

The demographic potential of Tug Fork would seem to be vitiated by topographic constraints. There are a limited number of "plant sites" in the basin and their attractiveness to outside industry would be only partly enhanced by provision of flood control and other water resource investments. Under existing political and economic systems of land management, there are not enough acres of developable land, with or without flood control, to support the labor market potential of the basin. Employment cannot be expected to come to Tug Fork, under normal operation of the economy, merely because people live in the basin who can be trained for the jobs. Lack of nearly all resources other than coal and timber, and remoteness from industrial markets, inhibit diversification.

Nevertheless, there is growth potential in the basin. The coal and associated transportation industries appear to enjoy prospects for stability. Since these industries import much of the goods and services they need, it appears that local planning should concentrate on developing facilities to provide for indigenous industrial and service requirements and improving general community amenities. Land-use and flood plain management measures should be implemented vigorously to assure utilization of all developable areas to their highest potential in resolving the problems of the area.

8. WATER RELATED NEEDS

General Problems

The analysis of water needs in the context of the developmental objectives of PL 89-4 is based on several considerations. These include:

a. Immediate needs;

b. The needs that result from the continued development of the basin and contiguous areas, with a normal development program; and

c. The needs that may result from accelerated development that is generic to development of an economy within the full capacity of the area to supply industrial sites, provide labor, developmental capital, and other needs.

Although the Tug Fork Basin has a generally adequate supply of water, there is a considerable amount of seasonal variation in rainfall and streamflow. Stream overflow occurs most frequently during the winter and spring with minimum flows being recorded in the late summer and autumn. Water resources problems of the basin are related generally to the seasonal fluctuations in flow, particularly concerning the excessive or flood flows. The basin and surrounding area are deficient in water-oriented recreational facilities and the addition of such facilities would attract some tourism. Although there is no current need for reservoir storage for water quality beyond that proposed in the authorized Panther Creek Lake, consideration should be given to adding such storage in the event a reservoir is provided for other purposes since attainment of growth visualized by developmental benchmarks will require additional flow augmentation. In addition FWPCA has indicated that if a water using industry would move into the area, an immediate need for low flow augmentation would be needed. There is need for watershed programs for flood retardation, erosion control and related problems in tributary basins of Tug Fork. Needs for development of water resources for other purposes such as water supply, irrigation and drainage would be for local uses only and would be provided as needed by local interests. Although there is need for hydroelectric power facilities for peaking purposes in the general area, advantages of Tug Fork sites over sites in other areas are not apparent at this time.

The area is an exporter of large quantities of coal, a commodity that is often susceptible to shipment by water at low cost. Some interest has been shown in the past in the possibilities of canalizing Tug Fork and the Big Sandy River to permit access to Tug Fork coal by waterborne transportation from the Ohio River. The Tug Fork channel is narrow, tortuous, and steep. Navigation facilities would be expensive and tows would necessarily be small and of slow speed. Past studies have shown this aspect of water resource development to be grossly infeasible and navigation has not been considered further herein.

Flood Control

Floods occur throughout the length of Tug Fork and its tributaries. Generally winter rains cause major flooding throughout the basin while summer thunderstorms may cause local flooding. Areas subject to flood damages consist generally of narrow strips of land along the valley floor together with irregularly dispersed and disconnected plots of relatively small, flat, flood plain. Basin configuration, rugged topography, and steep stream slopes cause rapid concentration of rainfall runoff and result in swift and erratic fluctuations in stream level. Warning time for impending floods normally is insufficient to permit removal or protection of business stocks and equipment, house furnishings, and personal properties. Extreme floods produce high velocities which may move buildings from their foundations and otherwise cause damages that are impossible or extremely difficult to repair. Coal mining wastes placed along the stream banks during normal conditions are flushed into the stream by flood flows. The finer mine wastes, together with silt and sand, are deposited in buildings, streets, and yards, thereby contributing to the cost and difficulty of post-flood cleanup. Inundation and damage to roads and railroads generally cause business paralysis throughout the area by disrupting the transportation of material and the mobility of the labor force. Improvement in equipment used in stripping and augering methods of mining and an increased demand for relatively low-grade fuel for steam electric plants have altered the economics of coal marketing so that surface mining has become much more extensive within the past 20 years. The large quantities of earth and vegetation displacement that is inherent in surface mining cause land erosion, contribute to localized flooding by obstructing flows, and accentuate problems of channel filling and deposition of silt and debris on the flood plains.

Although total population in the basin has declined over the past two decades, development in the flood plains of most of the larger streams has increased. The valley floods afford the most suitable terrain for development and continue to be developed regardless of the recorded flooding and flood damages, and despite publicity directed to flood hazard.

Flood damages inflicted along Tug Fork and the tributary Pond Creek during 3 major floods of the recent past are indicated in Table 13-3.

TABLE 13-3
FLOOD DAMAGE TABULATION
TUG FORK and POND CREEK

Reach	Date of Flood and Damages ($1,000) 1/ 2/		
	1967	1963	1957
Welch	$ -	$ -	$ 368.0
Welch to Iaeger	1.8	2.5	27.0
Iaeger	0.5	9.5	50.0
Iaeger to Matewan	162.8	35.0	166.0
Matewan	250.7	410.0	360.0
Matewan to Williamson	330.5	790.0	680.0
Williamson (inside wall)	(725.9) 3/	(820.0) 3/	640.0 4/
Williamson (outside wall)	133.4	520.0	450.0
South Williamson	25.2	108.0	80.0
Williamson to Kermit	499.4	570.0	420.0
Kermit to Ft. Gay	21.1	54.0	46.0
Pond Creek	274.0	560.0	450.0

1/ Based on 1967 costs and degree of development. Does not include damages to railroads, highways or utilities.
2/ Tabulation does not include all damage reaches or all categories of damage.
3/ Damages prevented by existing floodwall, not counted in totals.
4/ Floodwall did not exist - damages are at 1967 level of price and development.

Procedures Used to Measure Flood Damages

Local groups have taken considerable interest in collection and evaluation of flood damage data in the basin. On their own initiative, they have made surveys of damages in portions of the basin caused by specific floods, and have presented data concerning these surveys to the Corps of Engineers and other Federal and non-Federal agencies. They have disagreed with the findings of damage evaluations of the Corps of Engineers and have questioned computations of the relationship between frequency and flood heights. They are of the opinion that estimates of the Corps of Engineers are too low and are dissatisfied with the evaluation of damages of specific floods and average annual damages. In recognition of questions of the local people, it is considered advisable to present a summary in this report of procedures used in collection and evaluation of flood damages and computation of frequency - flood height relationship used for the Tug Fork Basin.

Flood damage evaluation and frequency relationships are discussed in the following paragraphs of this report.

In computing flood control benefits it is necessary to determine the magnitude of damages that will occur at various levels of flooding. Stage-damage relationships are developed by conducting surveys of the flood plain areas. Such relationships require periodic review and adjustment to keep abreast of evolving development within the area subject to flooding.

During the period since 1955, Tug Fork has been the subject of intensive and repeated field surveys and office studies concerned with flood damages. Field surveys were made after the 1955, 1957, 1958, 1963, and 1967 floods. Damage data are comprehensive and of adequate areal scope to accurately estimate the detrimental effects on local economy and the benefits that would occur from proposed improvements for flood control. Damage data on Tug Fork are more extensive than on other similar basins in the general area. Flood control benefits are based on the most current stage-damage tabulations available.

Physical damages to properties (tabulated in damage surveys by the Corps) included costs of clean-up, repair, and rehabilitation of affected properties. In addition to physical damages, losses were included for evacuation, reoccupation, flood fighting, and loss of business for establishments directly affected by floodwaters. These business losses were for businesses that could not recover the losses after the floodwater had receded by rescheduling production and deferring delivery and sales.

The most recent flood damage survey in the Tug Fork area is discussed in paragraph 22.

Procedures Used to Determine Average Annual Flood Damages

Average annual damages have been computed for selected reaches of Tug Fork and for major damage centers such as Williamson. The damages were based on relation of stage height and damages interrelated with stage height and frequency of occurrence ratios. These methods have been accepted as standard procedures throughout the nation for many years.

Stage height - damage relationships for each reach and major damage center along Tug Fork were obtained by combining all of the categories of damage into a composite curve. During the field surveys previously discussed, sufficient data were obtained to evaluate damages for a range of floods closely related to the past floods of record. These data, together with data obtained during previous surveys, were sufficient to construct accurate flood damage curves. A sample stage-damage curve for Williamson is shown on exhibit No. 13-12.

Discharge and stage frequency relation curves were developed for each of the stream gaging stations and at other points of special interest in the Tug Fork Basin. Analysis of frequency of flooding was based on standard procedures for statistical hydrologic probability determinations. The method is in accordance with procedures recommended by the Water Resource Council for use by all agencies engaged in water resource development. It should be noted that all floods of record are included in the analysis.

Water Supply

Ground water is used by many small communities in the upper and middle Tug Fork Basin as a source of municipal water supply. Wells, springs, and abandoned mines furnish virtually all communities in McDowell County. Four principal municipal systems in the middle and lower Tug Fork Basin serve about 17,000 persons and utilize approximately 2 cfs. Industrial use is confined primarily to coal washeries which use a combination of sources. Total use in the middle and lower basin is about 4 cfs.

Future use, based on industries likely to locate in the area, is expected to reach about 10 cfs in the middle Tug Fork reach by 2020. As the minimum recorded flow in the same area is about double the expected demand, there appears to be no need for reservoir storage for water supply.

Water Quality

Present organic waste loads generated by sewered municipalities and by industrial establishements were equivalent to a population equivalent of approximately 25,000 in 1960. Many of the smaller communities with central water supply systems are not sewered and waste loads generated by these communities are not included in the above value. In the future, total organic waste loads generated are projected to decrease slightly with a decrease in municipal waste loads not being entirely offset by increased organic waste loads generated by industrial activity.

Water quality problems in the Tug Fork Basin would be most critical at Williamson where the design flow is about 25 cfs. This streamflow is sufficient to meet the needs for assimilation of residual organic wastes discharges after secondary treatment. Acid mine drainage is not a problem on most streams, although localized problems do exist. The topography and regional economy are not considered conducive to development of industries that would have need for large quantities of water or that would contribute significant amounts of waste discharge. Location of a single, heavy-water-using industry in the basin would create an unanticipated demand for water supply and/or flow augmentation that would be available from the authorized Panther Creek Lake and the potential Lower Knox project. The latest analysis by FWPCA recognizes

that the goals of the Appalachian benchmarks will require industrial development in Martin County, Kentucky, that may create a need for additional flow regulation along the lower reaches of Tug Fork.

Recreation

Needs for water-oriented recreational facilities in the general area of Tug Fork Basin, including the adjacent basins to the east and west, are expanding beyond the capabilities of facilities existing or included in current programs. There appears to be an unsatisfied local need for additional stream and/or lake-type opportunity that could be satisfied elsewhere by further travel. Hunting demand will increase slightly from that existing but will not be of sufficient magnitude to warrant furnishing extensive facilities.

Estimates of future needs for water-based recreation in the Tug Fork general area were made as a part of the overall study of recreational requirements in the Ohio Basin. These estimates indicated unsatisfied Ohio Basin demands for recreational facilities would amount to 11 million recreation days by 1980 and approximately 30 million recreation days by 2020. These demands could be partially met by water resource development in the Tug Fork Basin in the event that regional and local access is improved to the basin and to potential recreational points.

9. ALTERNATIVES FOR MEETING NEEDS

Since there are unresolved flood problems that create a considerable amount of local concern, most of the investigations of potential water resources developments in the Tug Fork Basin have been related primarily to measures for reduction of flood damages. Various measures have been considered with a view to formulation of a plan of improvement that would provide the best solutions to the problems within the limitations of engineering feasibility and economic justification. Structural measures that have been considered are: a. reservoirs on Tug Fork and major tributaries upstream from centers of major flood damage; b. retarding reservoirs in headwater areas or on minor tributaries; c. flood barriers including levees, floodwalls, or combinations thereof; d. control gates and pumping stations to permit utilization of highway and railroad embankments as levees; e. channel improvement to reduce flood stages by increasing flow capacity; and f. diversion of flood flows. Non-structural measures considered are: a. permanent or emergency evacuation of the flood plain; b. zoning to prevent encroachment on floodways and channels and to control the type of development on the flood plains; c. floodproofing of facilities required to be on the flood plain; d. improving the flood warning system; and e. flood information studies and implementation of flood plain management programs.

In consonance with the concepts of comprehensive water resources planning, consideration was given to water supply, water quality control, recreation, and fish and wildlife enhancement for all potential projects in which multiple-use development would be practicable. Storage capacity was considered in potential reservoir projects to augment flows during periods of low stream flow along Big Sandy River downstream from the confluence of Tug and Levisa Forks. Also, needs for storage for flood control on the Big Sandy and Ohio Rivers were considered. Factors considered in evaluation of storage for water quality control included physical capacity of the potential impoundment, incremental costs of adding storage space, degree of interference with recreational activities and other forms of economic development, effects of providing flow augmentation along the maximum practicable reach of otherwise non-regulated streams, and effects on potential industrialization. Uses of potential reservoirs and adjacent lands for recreation and fish and wildlife activities were also considered. Factors affecting the recreational evaluation included terrain characteristics related to adaptability for recreational development, surface area of impoundment, release rates, estimates of seasonal or annual fluctuation in pool level, proximity and accessibility to population centers, and needs in the basin for recreational opportunities.

Structural Measures

Justification of projects for water resources development in the Tug Fork Basin is complicated by the topography and economic development in the area. Reservoir sites upstream from major damage centers that would control sufficient drainage area to provide significant reductions in flood damages have been found to require extensive relocations or abandonments of highways, railroads, mining facilities, or communities and to inundate or complicate the recoverability of coal deposits. Stream gradients and narrow valleys generally require unusually high and costly dams in relation to storage capacity. Lack of terrain suitable for industrial development downstream from potential reservoirs severely limits regional expansion effects that are normally induced by reservoirs as a result of improved flow conditions and reductions in flooding.

Flood protection by use of walls or levees is usually infeasible because dispersal of improvements and strip-type development along the narrow valley floors require protective projects to be lengthy, and therefore expensive, in relation to the overall size and value of the areas to be protected. In many instances, the improvements to be protected lie near the streams or encroach into the floodway so that space is not available for protective structures.

Dredging or channel improvement along Tug Fork or lower reaches of the larger tributaries is a very expensive operation. Although there is evidence of channel filling in some reaches, it is not significant in increasing flood stages. Increases in flow capacities (required to reduce flood heights) are normally accomplished by increasing the size or bottom slope of the channel, by removing flow obstructions, and/or by lining the channel to improve the flow characteristics. Increasing the size of a relatively large channel to a degree required to permit retention of overflows sufficiently to reduce flood damages to any significant degree would necessitate a substantial amount of widening, deepening and realigning. To be effective, the increased size must be extended a considerable distance downstream from the protected area. Acquisition of rights-of-way and properties required for widening or realigning often are complicated by proximity of improvements to the stream bank. Dredging and improving channels of tributaries are ineffective in alleviating flooding within the stream reaches that are subject to Tug Fork backwater, although somewhat effective in reducing stages from local floods.

Tug Fork and all tributary streams were considered in the examination of the basin for potential reservoir sites. Since the major damage area is in the Matewan-Williamson area, particular effort was made to locate reservoir sites upstream from these communities. Also, small flood control and multiple purpose reservoirs constructed as a part of land treatment and watershed management programs were considered for the basin.

The main line of the Norfolk and Western Railway Company extends along Tug Fork from Ft. Gay at the mouth to Welch and then along Elkhorn Creek to leave the basin in the extreme headwater area. Branch or spur rail lines constructed to serve coal mining facilities are located along most tributary streams that would be large enough to be considered for reservoir development with significant flood reduction capability.

Officials of the Railway Company are favorable to flood control since they recognize that stimulation of the local economy by water resource development would be beneficial to the Company and because flood damage to railway properties would be decreased. The officials do feel that suitable relocations should be provided for lines that would be affected by potential projects in order to avoid disruption of service to mines and other facilities and to avoid adverse effects on their operations and employment opportunities.

Since railroad property which would require relocations or abandonment is one of the major costs in many potential water resources developments, cooperative study has been made with officials of the Norfolk and Western Railway to determine if railroad operations could

be changed, including services provided to mine operators, so that reservoir sites with desirable characteristics could be made available for development at reasonable costs.

Some of the possible modifications discussed were whether freight from Weller Yard on Levisa Fork at Vansant, Ky., could be shipped out over the C&O Railroad to the north and west, and over the Clinch Valley Railroad connection to the south and east which would permit abandonment of the line through Knox Creek; whether the Dry Fork Branch line could be abandoned as a through route; and whether a main stem reservoir site could be provided by shifting main-line traffic over the Virginian Branch past R. D. Bailey Lake in the adjoining Guyandotte River Basin.

The Railway Company officials have made extensive studies to determine the needs for the various branch and spur lines and to consider the relocations that conceivably could be substituted. Studies were made for the potential Lower Knox Creek Project and for a potential project on Dry Fork. The Corps of Engineers made independent investigations of the necessity of railroad relocations, the most economical relocations, and estimated costs. Studies by representatives of the Railway Company supplemented those of the Corps of Engineers and were considered as indicating the needs and desires of the Company.

The following reservoir sites were selected for study in some detail as representing the most suitable sites in the basin for reduction of flood damages, for development of storage for improvement of water quality, for provision of recreational opportunities, and for enhancement of fish and wildlife development.

Reservoir Site Data

Item	Lower Knox Ck.	Upper Knox Ck.	Big Creek	Tug Fork	Dry Fork
Location, stream	Knox Ck. Ky. & Va.	Knox Ck. Va.	Big Ck. W. Va.	Tug Fk. W. Va., Ky. & Va.	Dry Fk. W. Va., & Va.
Tributary drainage area, sq. mi.	113.0	25.4	23.7	640	227
Storage capacity, total, ac. ft.	60,000	18,700	13,900	211,400	89,700
Pool area, maximum acres	865	300	285	2,680	1,075

A reservoir was considered on Knox Creek, Buchanan County, Va., with the dam located 15.3 miles above the mouth of the Creek. No rail relocation would be necessary but site conditions would require an expensive dam in relation to the small drainage area that would be controlled and the small storage capacity of the reservoir. Effects of the reservoir, acting alone or in combination with the authorized Panther Creek reservoir, in solving the flood problem along Tug Fork were inadequate. The site approached marginal economic feasibility when consideration was given to redevelopment benefits for creating jobs for otherwise unemployed or underemployed persons. The project was not retained for further study because of the marginal economic status, lack of significant stage reduction it effects, and because of the tremendous local interest in development of the Lower Knox Creek site in lieu of the upper site.

A reservoir was considered on Big Creek, a tributary of Jacob Fork, of Dry Fork, of Tug Fork, in McDowell County, W. Va. The dam site is 3.7 miles above the mouth of Big Creek and would not require rail relocation. However, numerous coal mine operations have extended under the reservoir site from adjacent valleys. Substantial costs would be required for sealing broken or faulted strata in order to avoid reservoir leakage and for costs of pumping necessary to remove seepage from the mine workings. The reservoir on Big Creek would have beneficial effects at War, West Virginia, and adjacent areas along Dry Fork and downstream along Tug Fork. However, the effects along Tug Fork would be small and not commensurate with estimated costs of the project.

Consideration was given to reservoir projects located on the lower reaches of Dry Fork and on the main stem of Tug Fork immediately upstream from the mouth of Knox Creek. The presence of railroads and coal deposits in the reservoir areas resulted in prohibitively high costs for relocations and site acquisition. Past mining under several potential Dry Fork sites similarly would cause high costs in preventing reservoir leakage. Reservoir projects with flood control storage sufficient to control the floods of record were estimated to cost more than 100 million dollars for the Dry Fork site and more than 150 million dollars for the Tug Fork site.

A proportional analysis of the mainstem site and the Big Creek sites as compared to the Lower Knox site clearly indicates that, although the costs are much more than the benefits that can be attributed to any of the three sites, the Lower Knox Creek site more nearly approaches feasibility.

Accordingly, detailed consideration was given to a reservoir on Knox Creek, Kentucky and Virginia, with the dam site located 0.4 mile above the mouth of the creek. A reservoir at this site would control a larger drainage area than the Upper Knox Creek and Big Creek sites, but a considerably smaller area than those controlled by the Tug Fork and Dry Fork Reservoir sites.

The site on Lower Knox Creek represents the most favorable conditions for reservoir development of the sites considered. No other reservoir sites were found in the basin that offered more favorable developmental conditions. However, even at this site, stream valley characteristics and required railroad relocations would result in a costly project. The estimated initial construction costs and annual charges are $49,200,000 and $1,891,000, respectively. Benefits to the region from the reservoir computed in the most favorable manner with allowance for development and redevelopment benefits and placing the project in a system with the authorized Panther Creek Reservoir, amount to $1,487,000, annually.

The high cost of the reservoir and limited benefits for flood control, water quality improvement and recreation, cause the project to be economically infeasible. However, local groups have been insistent that construction of the Lower Knox Creek Reservoir is necessary for growth and even for economic survival of the basin. Recognizing that the strong feelings of the citizenry should be accommodated to the extent practicable, investigations of the project were carried to the point that a firm determination was made that costs could not be significantly reduced nor benefits raised. In view of the intense local interest in the project, a summary of engineering and other aspects of the project is contained in the following paragraphs and a detailed presentation of project data is contained in later sections of this chapter.

Relocation of the Norfolk and Western Railroad facilities from the reservoir area is a costly feature . Coordinated studies were made by representatives of the Corps of Engineers and the Railway Company to arrive at the most economically satisfactory solution.

Company officials point out that the Knox Creek line is a very important branch line that serves to carry all the coal mined in the Knox Creek Valley and on the upper parts of Levisa Fork and Dismal Creek in Buchanan County, Virginia. Coal production in the upper Levisa Fork and Dismal Creek areas is expected to increase significantly because exploitation of a deep seam of high-grade metallurgical coal in the area has begun within the last decade and will be further developed in the future. The Railway Company is presently constructing a connection from the Buchanan Branch line on Dismal Creek to the Clinch Valley Branch line to the south. The new connection is expected to carry all eastbound coal from Dismal Creek and points upstream from Vansant, Virginia (Weller Yard). Eastbound coal shipment originating downstream from this point and all westbound coal shipment originating in the area served by the Buchanan Branch line will continue to pass through Knox Creek Valley.

The potential Lower Knox Creek Reservoir, operating in conjunction with the authorized Panther Creek Project, will provide substantial flood damage reductions but will not afford complete protection against large floods for the major damage centers. Stage frequency estimates indicate about 4 feet reduction in a 100-year frequency flood at Williamson, W. Va., due to the Lower Knox Creek Project, slightly more than one foot due to the Panther Creek Project, and about 4.5 feet reduction with the two projects combined. It should be recognized that reductions for specific floods may vary somewhat from reductions for other specific floods or typical floods because of differences in storm patterns and antecedent ground, vegetative, and weather conditions. For example, it has been estimated that the Lower Knox Creek Project would have reduced the 1963 flood by about 6 feet. The degree of protection provided by these projects singly or together will not eliminate flood problems along Tug Fork. Little or no new industrial activity can result from reduced flooding because there is a severe scarcity of developable industrial sites downstream from the projects that would be substantially improved by flood reductions or flow regulation.

It should be recognized that the Lower Knox Creek Project, as originally formulated, included storage capacity for water quality control purposes. After elimination of the project from the 1964 report due to economic infeasibility, the storage needed for this purpose was redistributed among projects which have subsequently become authorized for construction. Estimates of the Federal Water Pollution Control Administration indicated that the authorized projects would provide sufficient flow augmentation to satisfy all identifiable needs for water quality or water supply in the basin. Revised estimates of the FWPCA indicate that in order to reflect growth required to reach the Appalachian Regional benchmark goals, additional flows will be needed by year 2020 on Tug Fork in Martin County, Ky. Therefore, the latest formulation of the Lower Knox Creek Project includes storage required to satisfy the 2020 benchmark need and needs of any heavy water using industry which might locate along Tug Fork.

Public Law 89-72, the Federal Water Projects Recreation Act, requires non-Federal interests to assume 50 percent of the separable costs of recreational development and the costs of operation and maintenance of the recreation facilities thereafter. The State of West Virginia and Commonwealths of Kentucky and Virginia have expressed general approval of the proposed Lower Knox Creek project, and of the potential for recreational development. In addition, the State of West Virginia and the Commonwealth of Kentucky have expressed interest in possible interstate cooperation should the project be implemented. Optimum recreational development has been included in the project in order to reflect the most favorable economic status likely to be attained. In the event a recommendation were to be made for authorization of the project, it would be necessary to obtain assurances of non-Federal cost sharing from one of the states, an interstate cooperative body, or some other non-Federal entity. In addition there is currentlyly only a low-lying,

frequently flooded, unimproved road to the dam site. A light-duty paved road passes through the reservoir area near its headwaters. Extensive road development by the Kentucky Department of Highways will be necessary to realize the recreation potential of the project.

The Soil Conservation Service, Department of Agriculture, gave preliminary consideration to 85 potential floodwater retention structures, with 60 sites upstream from Williamson, in the Tug Fork Basin. This analyses indicated that the 85 structures operating as a system would be clearly infeasible for main stem control, but several showed merit for tributary flood damage reduction and multiple purpose development. Subsequently, a work plan has been completed for the Mate Creek Watershed, Mingo County, West Virginia. This plan is currently being reviewed and recommends improvements consisting of three floodwater retarding structures, one multiple-purpose structure, about 4.2 miles of channel improvements (cleanout and bar removal), and accelerated land treatment.

Local Protection Projects

In addition to investigations of feasibility of reduction of flood damages over relatively widespread areas, local improvements for protection of specific areas were considered for many localities in Tug Fork Basin. In some instances, field reconnaissance, supplemented by map study, were adequate to determine the infeasibility of structural measures for flood control. In other instances, detailed analyses were required to evaluate a project acting alone or as a system in combination with other projects. Streams that were investigated with no economical solution of the flood problems found include Pond Creek, Blackberry Creek, Beech Creek, Bens Creek, Pigeon Creek, Four Pole Creek, Buffalo Creek, Big Creek, and Elkhorn Creek.

In addition, investigations were made of potential local improvements at Matewan, West Williamson, Welch, Chattaroy and Crum. Also, consideration was given to increasing the degree of protection provided by the existing local flood protection project at Williamson, W. Va.

Somewhat detailed analysis was made of potential channel improvement projects for Elkhorn Creek upstream from Welch, W. Va., and for Pond Creek in Kentucky. No feasible means of alleviation of flooding was found.

Appalachian Highway Corridor G is planned for construction along Pond Creek in Kentucky. The Corps of Engineers, the Kentucky Highway Department, and the engineering consultant for the Highway Department are coordinating design of the Corridor in an attempt to provide protection against Tug Fork flooding for a maximum amount of existing improvements and developable land. The potential protection

will involve utilization of the highway as a levee, channel relocation and improvement, and methods of preventing entrance of backwater and discharging internal drainage during flood periods. If found to be feasible, such protective works can be constructed under continuing authority made available by Congress to the Corps of Engineers.

Matewan, W. Va., located 70 miles upstream from the mouth of Tug Fork and about 13 miles upstream from Williamson is subject to frequent and severe flooding. The main business part of Matewan lies on a small flood plain between Tug Fork and the main line of the Norfolk & Western Railroad. The rest of the town, including most of the residential structures, the schools, and several commercial establishments lie adjacent to Mate Creek which is tributary to Tug Fork. Consideration was given to several proposals for protection of all or portions of the community. No economically feasible schemes were found for flood protection of either part of the community.

In addition to investigations of the Corps of Engineers, the West Virginia Road Commission considered a relocation of State Route 49 which now enters Matewan via a railroad crossing at the west (downstream) end of town, extends through the business part of town on the riverward side of the railroad, passes under the railroad near Mate Creek and extends upstream along the north bank of Mate Creek for several hundred feet, bridges the creek and follows the south bank downstream to the Norfolk & Western Railroad line, and then leaves the area by extending along the landward side of the railroad to the south (upstream along Tug Fork). Three alternative schemes were considered for the relocation. Schemes one and two would follow close to the river bank through the main part of Matewan and then cross Mate Creek via a bridge or culvert, cross the railroad track and rejoin the highway south of Matewan. The difference between schemes one and two is that one involves a grade crossing of the rail line south of Mate Creek and the other would provide for an overhead crossing. Scheme three would bypass the business part by extending along the hillside on the landward side of the railroad, cross Mate Creek and rejoin the line of the road on the south bank of Mate Creek with no crossing of the main line of the railroad being required. The hillside relocation and the river bank relocation with grade crossings were somewhat similar in estimated construction cost with the plan utilizing the overhead crossing being about four times as expensive. The river bank relocation would have served as a levee. The State has determined that the hillside relocation is most feasible and plans to accomplish this relocation at some future date. This alignment has no effect on flooding and cannot be utilized for flood protection. The Economic Development Administration is giving consideration to the situation at Matewan to determine whether that agency can justify issuance of grants and loans for construction of flood protective works. Justification by that agency would involve consideration of potential social and psychological impact to a large degree in addition to flood control and redevelopment aspects.

A study under authority for small flood control projects (Section 205 of 1948 Flood Control Act, as amended) is under way to determine the feasibility of providing a limited degree of protection against Tug Fork flooding for West Williamson, W. Va. The protection would be about equivalent to the degree provided by the project at Williamson. The project would utilize existing road and railroad embankments as levees and the improvement would consist of installation of larger or additional pumps to replace or supplement those presently owned and operated by local interests for discharging internal drainage during flood periods. Some revisions would also be required to the internal drainage collection system and to the gates or closures on the culverts or drains through the levees to prevent entrance of backwater when the project is being operated for flood control purposes. Some improvements such as the Armory and a proposed Marshall University Branch facility would be beyond the levee and therefore would not be protected by the project. The U.S. Office of Education, Marshall University, and the design consultant have been provided with flood hazard information for the site of the proposed University structure, together with suggestions for site utilization that would minimize potential flood damages.

Several locations were investigated to determine the feasibility of using existing railroad or highway embankments as a levee for flood protection purposes. Such utilization would require installation of control gates on culverts and drains to prevent entrance of backwater and pumping stations to discharge internal drainage during flood periods. In addition to the potential improvement at West Williamson, analysis has been given to potential projects of this nature for Lick Creek at Crum and for Buffalo Creek at Chattaroy in West Virginia and for Julius Branch in Kentucky. None of the potential projects were found to be feasible from an economic viewpoint.

The Williamson Local Protection Project was designed to protect against floods similar in magnitude to that of January 1957 (maximum of record at the time the design was accomplished). In 1963, while the project was under construction, the currently largest flood of record occurred. Emergency sandbagging measures prevented flanking the incomplete upstream end but overtopping did occur along a short section of the completed wall. The pump station was able to avert serious damage by discharging the inflow. Subsequently, the upstream part of the wall was raised and extended somewhat to provide a more uniform degree of protection throughout the entire project.

The Williamson LPP was designed to provide protection against floods that were estimated at that time to have an average recurrence

interval of once in about 75 years. Frequency estimates have been reviewed periodically and appropriately revised as additional statistical data became available. The level to which the project will provide protection currently is estimated to have an average recurrence frequency of one time in 26 years.

Extending and raising the wall to provide additional protection have been found to be infeasible. The wall was not designed to permit increasing the height and such revision would involve considerable rebuilding or substantial strengthening. The wall would require extension where it now connects to high ground with much of the extension being through an area containing shops and warehouse structures. Extension would require abandonment of the existing facilities or provision of numerous gate openings through the wall. Any substantial increase in height would involve placing gates or barricades at two locations across the main line and several side tracks of the N&W Railway. The likelihood of exceeding the level of protection provided by the Williamson Project would be reduced by construction of the authorized Panther Creek Lake Project or other potential upstream reservoir projects.

10. PROJECT FORMULATION - LOWER KNOX CREEK RESERVOIR

Because of the tremendous amount of local interest in the Lower Knox Creek Reservoir Project and because that project is the most practical solution considered that will satisfy a significant portion of the flood control needs at the major damage centers in the Tug Fork Basin, a detailed discussion of that project is presented in the remaining part of this chapter.

All pertinent major phases of water resources development were considered in the project formulation, including flood control, water supply, water quality control, hydroelectric power, general recreation and fish and wildlife conservation.

Investigations of potential sedimentation rates were made for the proposed reservoir site in order to provide sufficient storage for sediment accumulation without encroaching on the flood control and water quality purposes of the project. The U. S. Department of Agriculture Miscellaneous Publication No. 964, "Summary of Reservoir Sediment Deposition Surveys Made in the United States Through 1960" was used as a guide in determining the expected sedimentation rate. It was determined that a storage capacity of 2,270 acre-feet would be needed to provide for the deposition of sediment over the 100-year project life.

Based on a report by the Federal Water Pollution Control Administration, water supply is not expected to be a problem in this area; therefore, it was not included as a purpose in the project.

Water quality demands were based on criteria as presented in the report by the FWPCA, which has estimated that by the year 2020 an assured flow of 70 cubic feet per second will be needed in Tug Fork in the vicinity of Kermit, West Virginia, for the assimilation of residual organic and industrial wastes. A portion of this need will be supplied from the previously authorized Panther Creek Reservoir. Based on a simulated reservoir operation for the critical period of record (1930-31), 6,020 acre-feet of storage would be necessary for water quality control in Lower Knox Creek Reservoir. This amount of storage, in conjunction with releases from the Panther Creek Reservoir, would maintain the required 70 cubic feet per second at Kermit.

Consideration was given to the inclusion of hydroelectric power development at the project. Studies made by the Federal Power Commission showed that the development of power potential at the Lower Knox Creek site was economically infeasible at this time. Hydroelectric power was, therefore, not included as a purpose in the project.

Poor access, severe topography, adverse effects of exploration and exploitation of natural resources and the relatively small pool area limit the recreational use of the reservoir. General recreation and fish and wildlife recreation development is envisioned as serving primarily the local area, and the provisions of public use facilities are predicated on the primary utilization of the project for water quality control and flood control. A future increment for recreation was considered, but was considered to be negligible. However, if the project would be authorized an additional increment would be considered in advanced planning. The water quality control pool would thus be utilized for recreational development. The 7-day once-in-ten-year drawdown for water quality control would reduce the surface area of the pool from 220 acres to 187 acres, or approximately 15 percent. Therefore, the fluctuating pool caused by operations for water quality control would not be of a degree to adversely affect the recreation use. It was assumed that the water quality from the watershed above the reservoir would be appropriately maintained so that the water quality control and recreation functions would not be damaged.

Three levels of development were considered for flood control for formulation purposes. The low evaluation level was based on the storage required to control all floods of record at the dam site; however, reductions of damages from major floods along the lower Big Sandy River and along the Ohio River would be minimal. An intermediate

level of development was based on providing not only sufficient storage to effectively control recorded and historical floods in the Knox Creek Basin, but also to reduce damages from major floods on the Big Sandy and Ohio Rivers. The high evaluation level was based on limitations of the basin and the cost of railroad relocations which would increase sharply for any increment of higher development. The relatively small increase in flood control benefits due to the higher evaluation level would not, however, justify the increased cost of construction. Therefore, the intermediate level of development was adopted. The storage capacities and surface areas of the adopted plan are shown in the following table.

TABLE 13-4

PERTINENT POOL DATA

Pool	Surface elevation	Capacity: Acre-feet Net	Capacity: Acre-feet Accum.	Capacity: Inches Net	Capacity: Inches Accum.	Pool area acres
Permanent	788	2,270	2,270	0.4	0.4	101
Water quality control and recreation	826	6,020	8,290	1.0	1.4	220
Flood control	925	47,950	56,240	7.9	9.3	869
Total storage	925	56,240		9.3	9.3	869

SECTION III - DESIGN CONSIDERATIONS

11. INTRODUCTION

Hydrologic, geologic, and cost analyses were made to determine the storage requirements and structural design of the Lower Knox Creek Reservoir project to assure compliance with established design criteria and fulfillment of the proposed purposes at the least cost.

12. HYDROLOGIC

Hydrologic analyses were made to determine the storage allocations needed to accomplish the proposed project purposes and to establish the hydraulic design of the structure. These analyses include evaluations of available hydrologic records and preparation of hypothetical floods used for structural design. A brief description of hydrologic characteristics of the project area and design data for the dam and reservoir follow.

General climatology. The Tug Fork Basin is covered by a network of official climatological and/or hydroclimatic stations operated by the U. S. Weather Bureau. Stream gaging stations in the basin are operated by either the U. S. Weather Bureau or the U. S. Geological Survey.

The climate is temperate and includes the usual seasonal variations in temperature. Frequent and rapid changes in weather occur, due to the passage of fronts associated with general low pressure areas. Temperatures are highly variable; extremes of 105 degrees above zero and 22 degrees below zero have occurred. Temperatures in excess of 100 degrees are rare and sub-zero temperatures are rare. The mean annual temperature is 50 degrees.

Average annual precipitation over the Tug Fork Basin is about 44 inches and snowfall averages about 18 inches (unmelted) annually, representing only a minor portion of the total precipitation.

Storms. The Tug Fork Basin lies in the path of extensive meterological disturbances which, in winter and spring, generally travel from southwest to northeast. Two distinct types of storms result in floods; that is, summer and winter types. The summer type usually occurs during the period May through October and is characterized by rainfall of high intensity, short duration and relatively small areal extent. The winter type storm occurs from December to April and is of less intense rainfall but of extended duration and large areal extent. Storms of the convectional type (thunderstorms) are also prevalent.

Water losses. Infiltration losses during a storm are lowest during the winter season. Studies of past floods of high magnitude during this season indicate an hourly loss of 0.02 inches per hour to be a representative value. Losses during the dry summer and early fall are much larger; having been found to be as high as 0.2 to 0.3 inches per hour. Review of hydrologic records indicates that a minimum loss of 0.05 inches per hour during summer type storms is a representative value.

Runoff. The mean annual runoff from the Tug Fork Basin is slightly more than one cubic foot per second per square mile. The monthly and annual runoffs and the maximum flood of record at the Kermit gaging station are shown in Table 13-5.

TABLE 13-5

RUNOFF AT KERMIT, W. VA.

Station	D.A. (sq.) (mi.)	Years of record	Annual Runoff (in.)			Max. Flood	
			Mean	Max.	Min.	Stage (ft.)	Disch. (cfs)
Kermit	1,185	26	15.09	24.08	5.20	45.7	69,600

Existing reservoir storage. There are no existing reservoirs in the Tug Fork Basin. The Panther Creek Lake project, authorized by the 1965 Flood Control Act, will provide 1,700 acre-feet of inactive storage, 5,100 acre-feet of water quality control storage and 10,080 acre-feet of flood control storage.

Major known floods. The Tug Fork Basin has experienced numerous floods throughout the past 100 years as evidenced by historic data obtained from numerous sources and, in more recent years, by systematic observation of river stages. The first noteworthy flood of record occurred in 1862, followed by the flood of July 1875 which was the maximum of record along Tug Fork until the flood of January 1957. The flood of March 1963 exceeded the flood of 1957 along the middle reaches.

Flood frequencies. Discharge and stage frequency curves were developed for each of the stations in the Tug Fork Basin. Analysis of frequency of flooding was based on procedures outlined in "Statistical Methods in Hydrology" by Leo R. Beard, dated January 1962, and published by the Corps of Engineers. This method of analysis also complies with instructions contained in Water Resources Council Bulletin No. 15, "A Uniform Technique for Determining Flood Flow Frequencies."

Modified conditions. Modified frequencies were obtained by routing major floods of record and the standard project flood downstream from the reservoir. The reductions in flows, that is the difference between natural flow at the dam site and the reservoir outflow, were routed downstream by the "Muskingum Method." The following table shows the

reductions in flows at Williamson attributable to the authorized Panther Creek Lake and the Lower Knox Creek Reservoir.

TABLE 13-6

DISCHARGE-FREQUENCIES
AT WILLIAMSON, W. VA.
(938 square miles drainage area)

Flow Conditions	Peak discharge (1,000 cfs) for indicated exceedence frequency					
	100 year	50 year	20 year	10 year	5 year	2 year
Natural	72.0	60.5	47.0	38.0	31.0	21.5
Panther	67.8	57.2	44.8	36.5	30.0	20.8
Lower Knox	58.9	49.8	39.2	32.5	26.6	18.5
System	57.1	48.3	38.0	31.3	25.5	17.6

Note: Channel capacity is 18,800 c.f.s.

Storage allocation to proposed purposes. The Lower Knox Creek Reservoir project was designed to provide storage space for water quality control, flood control and sediment deposition, and also to accommodate associated recreation activities. Allocations to the various purposes are as shown in the following:

Purpose	Storage Capacity (ac.-ft.)
Sediment deposition	2,270
Water quality control	6,020
Flood control	47,950

Water quality control. The storage to be provided for water quality control was selected on the basis of project formulation studies described in Section II of this chapter.

Flood control. Investigations of flood control storage requirements were made with a view not only toward providing sufficient storage to effectively control recorded and historical floods in the basin, but also to reduce damages from major floods along the Big Sandy and Ohio Rivers. Allocated flood control storage was determined by a hydrologic analysis of selected representative floods with consideration given to optimum performance, cost efficiency, site limitations, risks and operations efficiency. Based on this analysis, 47,950 acre-feet of storage has been provided in the project.

Sediment. As described in Section II of this chapter, 2,270 acre-feet of storage space has been allocated for the deposition of sediment.

Area and capacity curves. Area-capacity determinations were based on data obtained from 7-1/2 minute quadrangles of the U. S. Geological Survey. An electronic computer was used to compute the area-capacity tables at one-foot intervals from which the area-capacity curves were developed.

Standard project flood. The standard project storm and flood for Lower Knox Creek Reservoir was based on data as presented in EM 1110-2-1411. Seasonal variation of generalized estimates of rainfall indicates that summer-type storms are more severe than winter-type. A review of summer-type storms indicated that a minimum infiltration rate of 0.05 inches per hour might be experienced after an initial loss of 1.0 inch. Rainfall increments were rearranged in critical sequence prior to reconstitution of standard project flood hydrographs for required locations. Pertinent data on this flood are shown in Table 13-7.

TABLE 13-7

HYPOTHETICAL STORM AND FLOOD DATA

	Standard project flood	Spillway design flood
Total rainfall, inches	15.15	26.12
Total losses, inches	3.14	3.99
Total rainfall excess, inches	12.01	23.05
Peak discharge, c.f.s.		
Natural	63,400	128,400
Inflow		160,400
Outflow	21,500	132,000
Maximum reservoir elevation, ft., m.s.l.	933.2 1/	954.9 2/

1/ Pool at elevation 826 at onset of flood
2/ Pool at elevation 925 at onset of flood

Spillway design flood. The spillway design flood was computed from generalized estimates presented in Hydrometerological Report No. 33, prepared by the U. S. Weather Bureau. Rainfall values obtained from HMR No. 33 were reduced 12.74 percent in accordance with criteria presented in Engineer Circular No. 1110-2-27, dated 1 August 1966. Pertinent data are given in Table 13-4.

Hydraulic design. The hydraulic design of the project includes the determination of elevations, dimensions and shapes of the hydraulic features pertaining to the spillway, number and size of outlets, type of energy dissipators and elevations for the proposed spillway and dam. The hydraulic investigations conformed to the usual procedures for structures of this type and were supplemented by data contained in

Engineering Manuals, Hydraulic Design Criteria and the results of model and prototype studies for similar structures.

Recommended spillway. The spillway would be uncontrolled and largely unlined, excavated through the ridge of the left valley wall. The spillway crest at elevation 925 would be a 250-foot wide, broad-crested weir with a short section of the spillway at the crest being concrete lined to insure that the control would remain at the desired elevation.

Flood routing results. The spillway design flood has a peak natural flow of 128,400 cubic feet per second at the dam site and a peak inflow rate of 160,400 cubic feet per second into the reservoir. Assuming the reservoir is filled to flood control pool elevation 925 at the onset, the spillway design flood was routed through the spillway. This resulted in a maximum pool elevation of 954.9 and a peak outflow of 132,000 cubic feet per second. Hydrographs of inflow, natural flow and outflow and pool elevation curves for the spillway design flood are shown on exhibit No. 13-2.

The standard project flood was routed through the reservoir, assuming the reservoir pool level at water quality control pool elevation 826. Results of this routing produced a maximum release of 21,500 cubic feet per second and a maximum pool elevation of 933.1 feet, or 8.1 feet above maximum flood control pool (see exhibit 13-3).

Reservoir regulation. Any reservoir located in the Tug Fork Basin must be considered a part of an integrated flood control and low flow regulation system; therefore, the method of regulation for the Lower Knox Creek Reservoir project must be correlated with the operation of other reservoirs in the system for the purpose of obtaining optimum performance from the entire system. In addition to overall system requirements, full consideration has been given to local requirements downstream from the project. The adopted plan is based on the assumption that an adequate flood forecasting and warning system would be in operation.

Control points. During periods of storm runoff, the reservoir would be operated to utilize the natural channel capacities by releasing storage, but not to exceed the designated control stages below the dam as given in Table 13-8.

TABLE 13-8
CONTROL STAGES

Station	Stream	Drainage area (sq. miles)	Control stage in feet	Control flow in c.f.s.
Williamson	Tug Fork	938	28.5	18,000
Kermit	Tug Fork	1,268	30.0	23,000
Louisa	Big Sandy	3,870	24.2	1/

1/ Slope rating - control discharge varies

For Ohio River floods, closure of the reservoir would be based on a crest stage forecast in excess of 54.0 feet at Ashland.

Reservoir regulation effects - Flood control. The proposed plan of flood control regulation for Lower Knox Creek Reservoir was tested by application to (1) major floods of record, (2) 12 representative Ohio River floods, (3) the standard project flood for the reservoir and (4) standard project floods on Tug Fork at Williamson and Kermit. Reservoir reductions were determined and routed downstream to obtain modified hydrographs which indicate the reservoir effects on the natural hydrographs. Table 13-9 presents the natural and modified stages at Williamson for 4 selected floods and Table 13-10 presents effective reductions at Ashland. A study of the probable frequency of floods was made to provide an index to flood characteristics downstream from the reservoir and modified frequency curves were determined for selected stations. The estimated chances of overtopping the existing Williamson floodwall, under present conditions, are as follows:

a.	With no upstream reservoirs	4 times in 100 years
b.	With Panther Reservoir only	3 times in 100 years
c.	With Panther and Lower Knox Reservoirs	1.5 times in 100 years

Frequency curves for Tug Fork at Williamson are shown on exhibit No. 13-4.

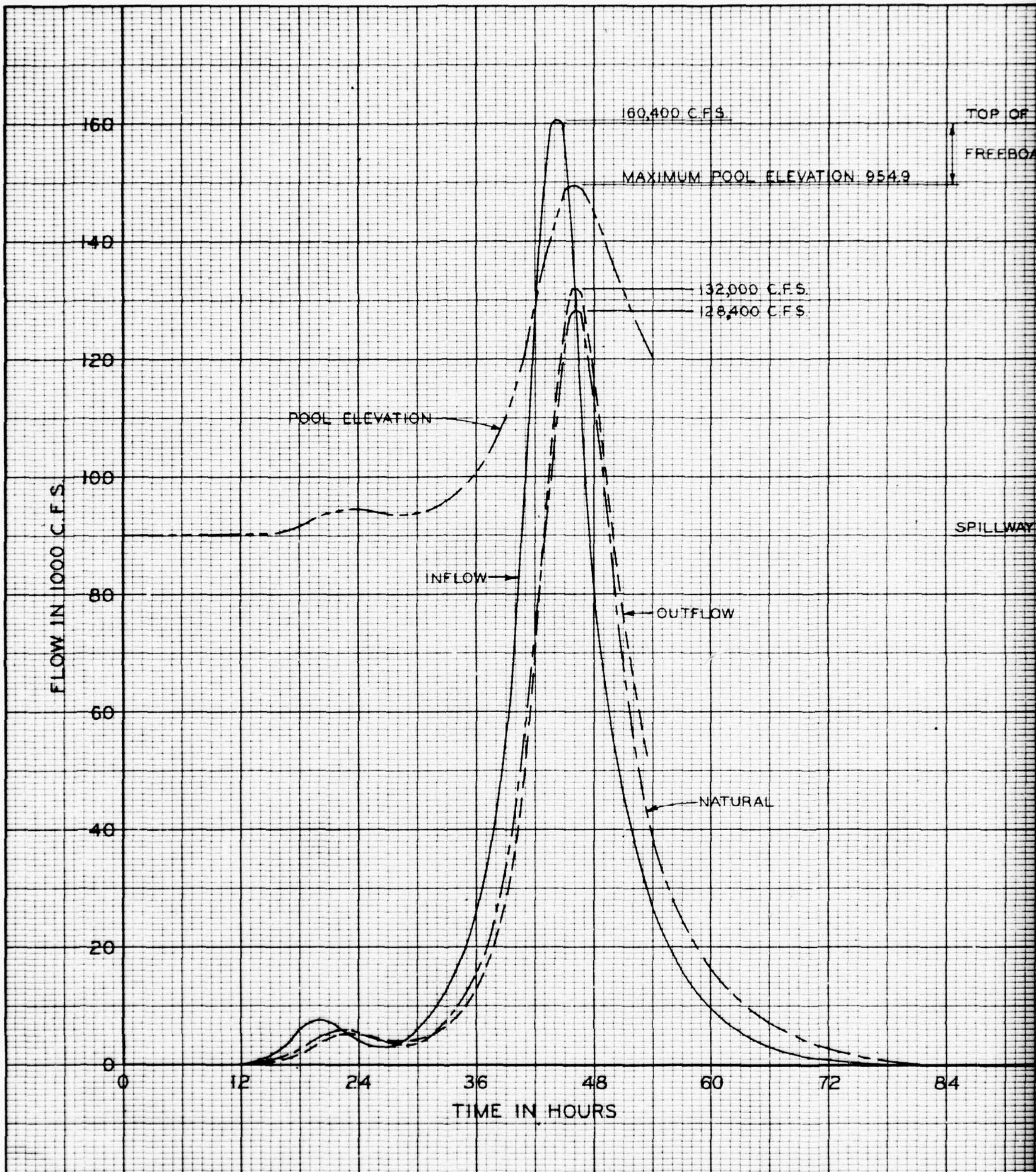
TABLE 13-9

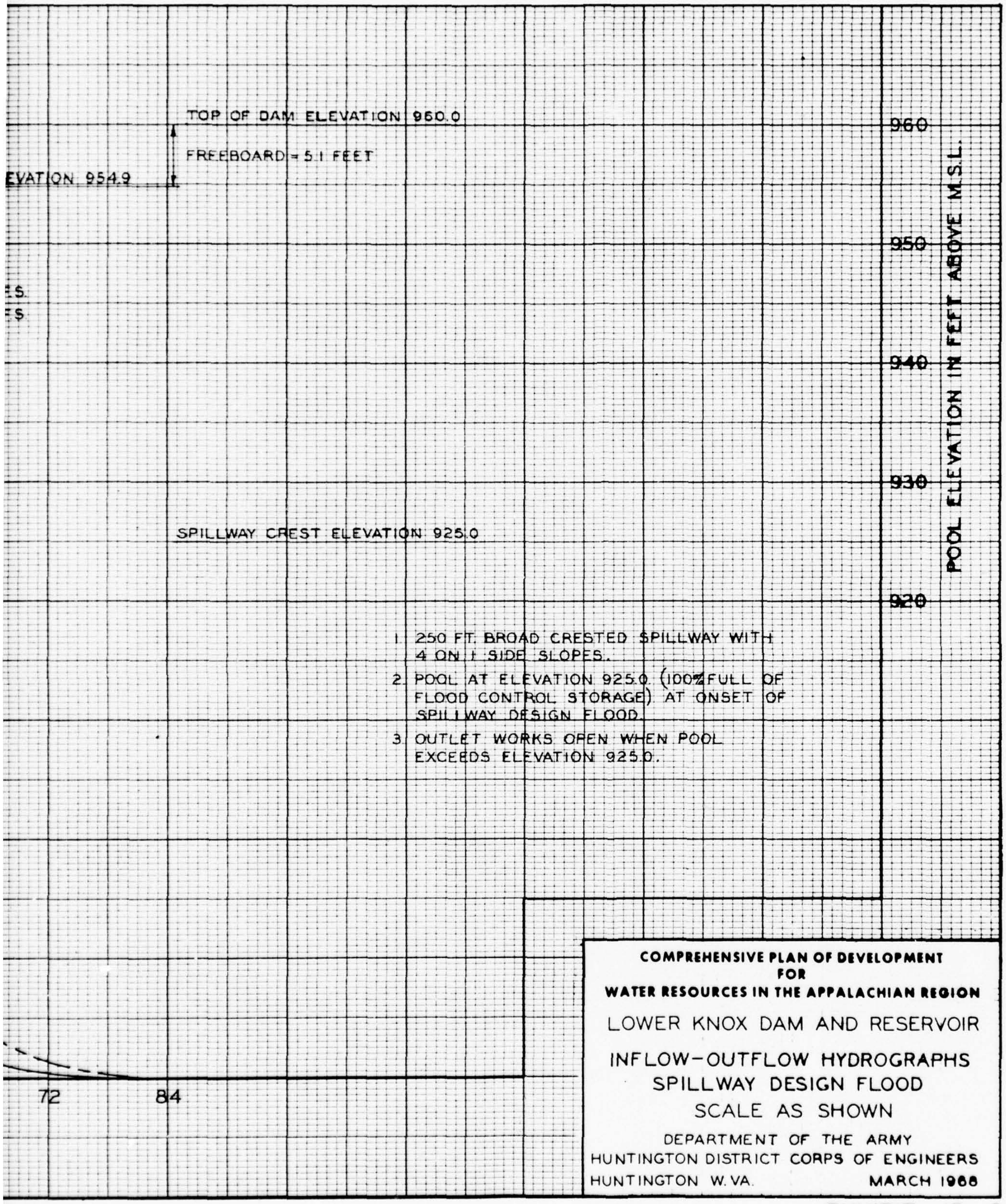
REDUCTIONS EFFECTED DURING SELECTED FLOODS AT WILLIAMSON, W. VA.

Flood	Natural stage* (feet)	Modified stage due to Panther Creek Reservoir	Modified stage due to Panther Creek and Lower Knox Reservoirs	Reduction attributed to Lower Knox Reservoir
February 1939 Williamson, USWB	28.8	28.4	25.3	3.1
February-March 1955 Williamson, USWB	37.0	35.9	32.3	3.6
January-February 1957 Williamson, USWB	43.7	42.9	39.4	3.5
March 1963 Williamson, USWB	44.6	43.7	40.4	3.3

*Latest gage site and ratings. Stage may differ from actual recorded reading because of changes in sites or ratings.

CORPS OF ENGINEERS





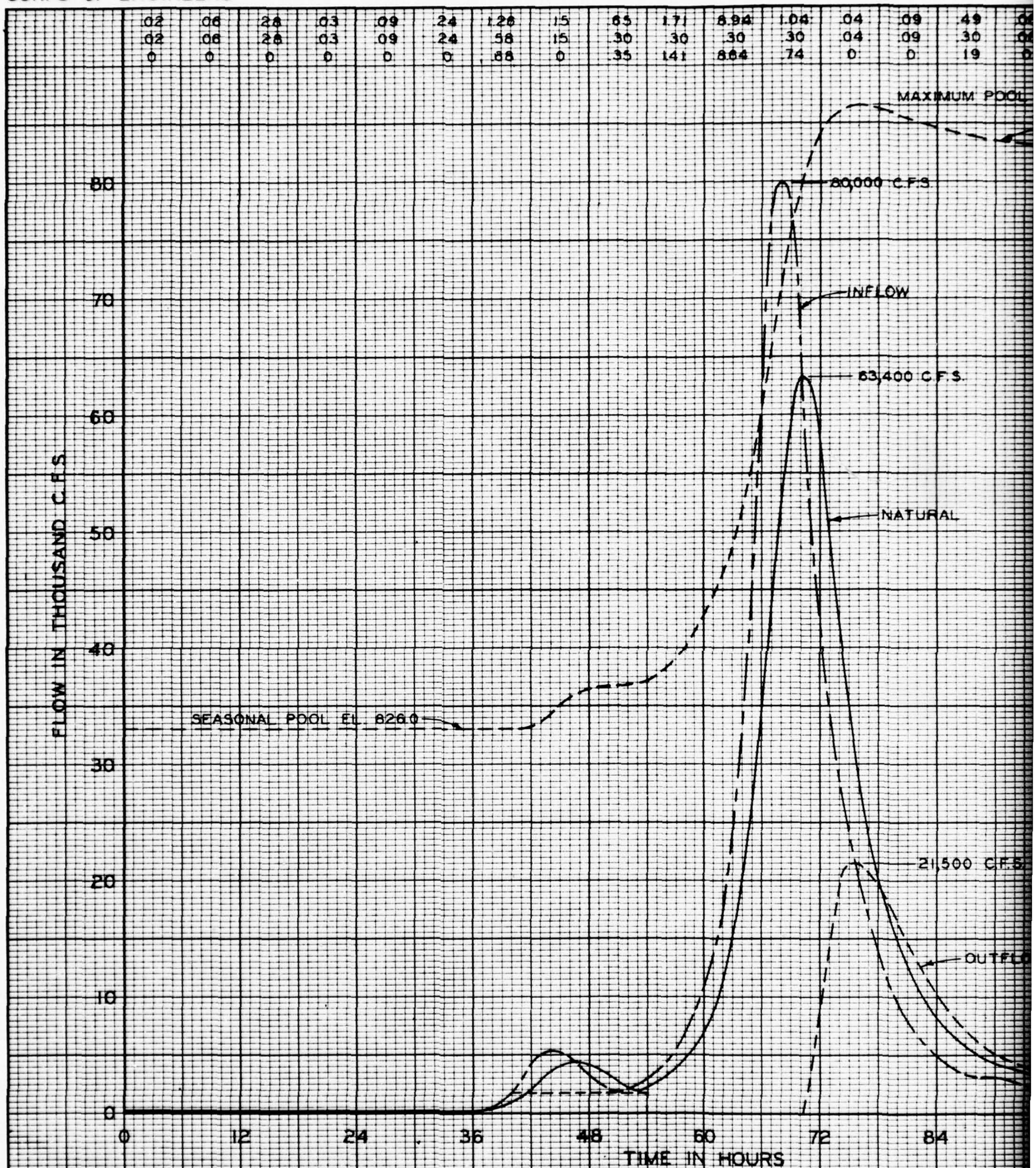
COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

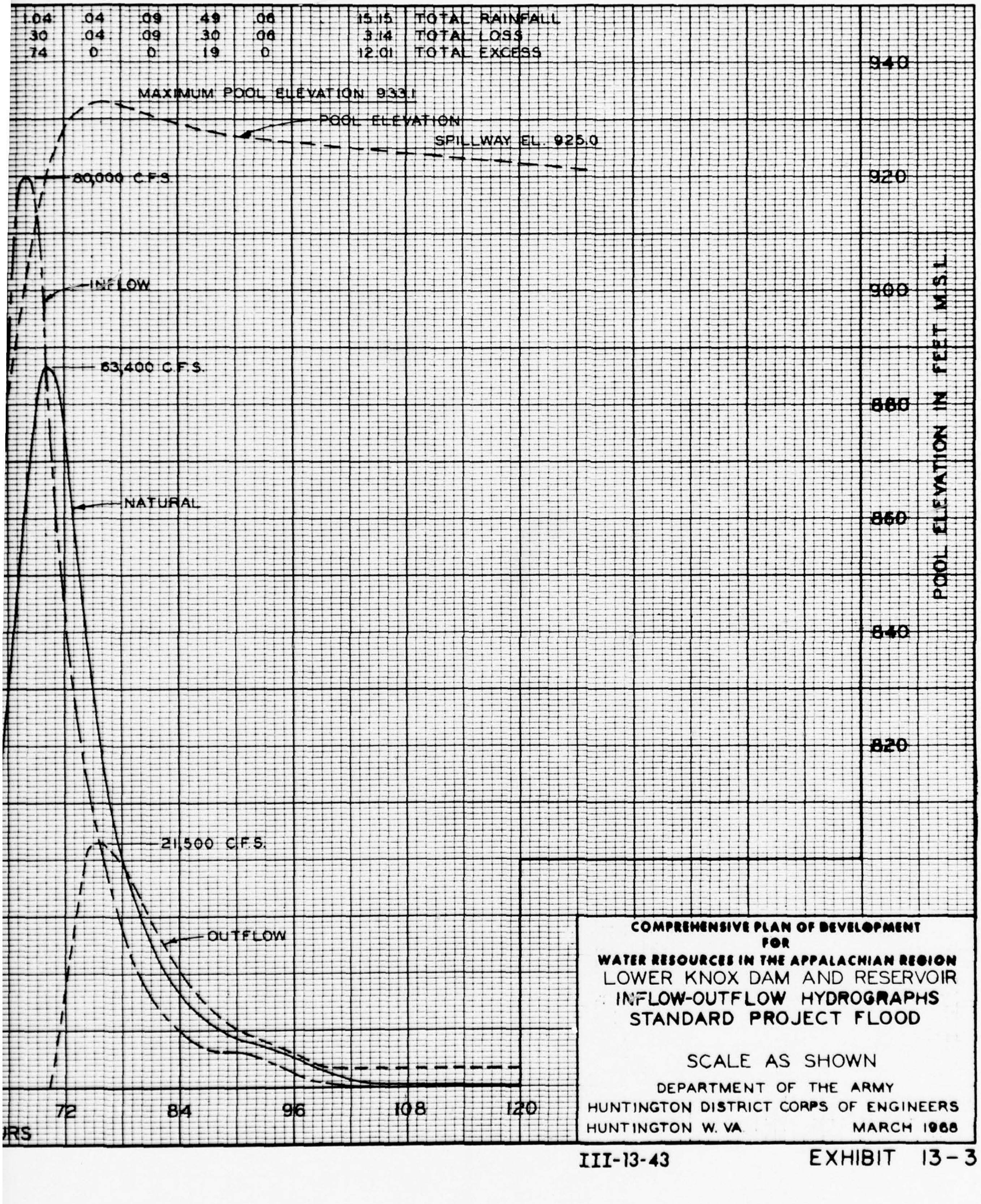
LOWER KNOX DAM AND RESERVOIR

INFLOW-OUTFLOW HYDROGRAPHS
SPILLWAY DESIGN FLOOD
SCALE AS SHOWN

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT CORPS OF ENGINEERS
HUNTINGTON W. VA. MARCH 1968

CORPS OF ENGINEERS





COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
LOWER KNOX DAM AND RESERVOIR
INFLOW-OUTFLOW HYDROGRAPHS
STANDARD PROJECT FLOOD

SCALE AS SHOWN

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT CORPS OF ENGINEERS
HUNTINGTON W. VA. MARCH 1968

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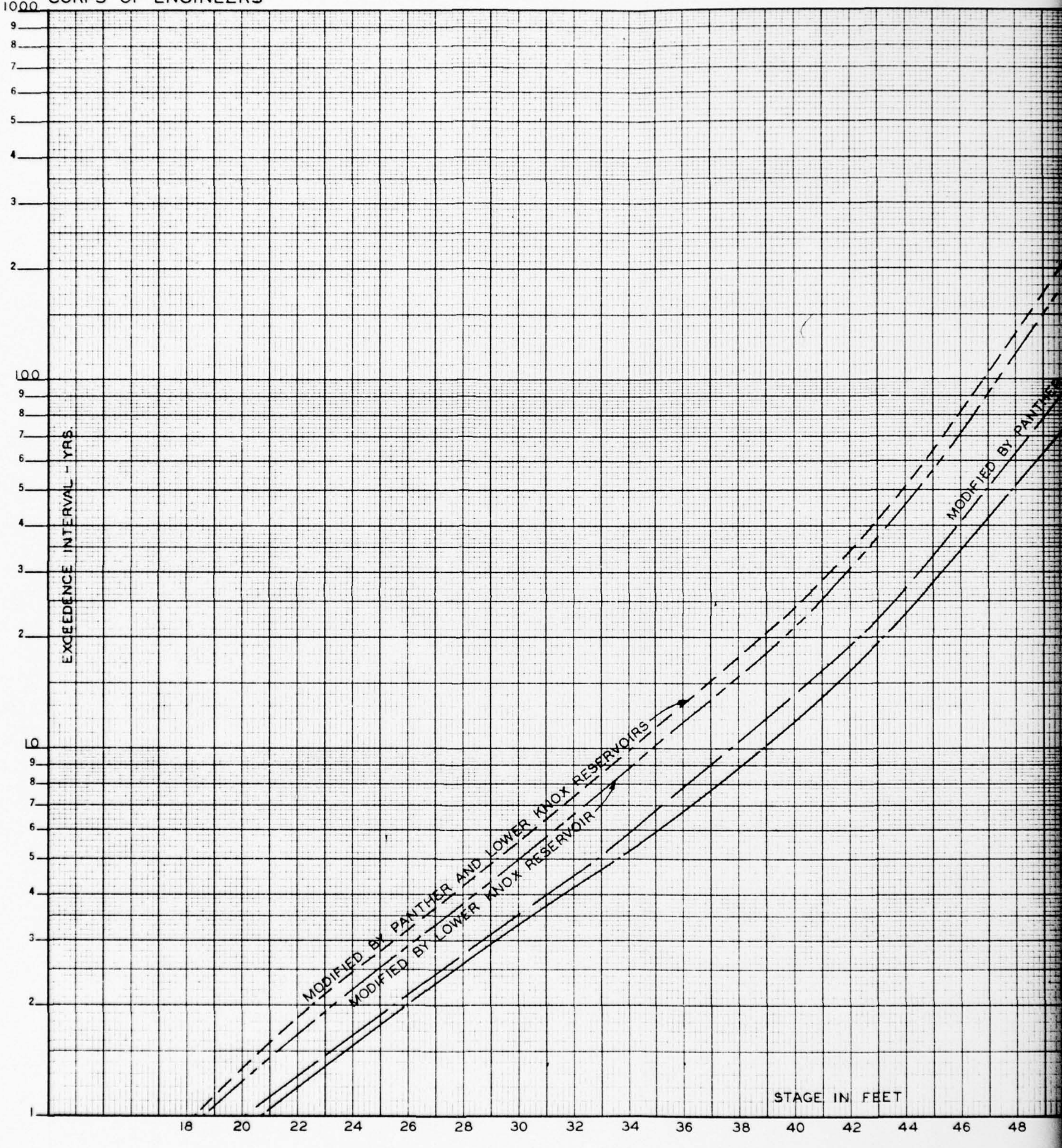

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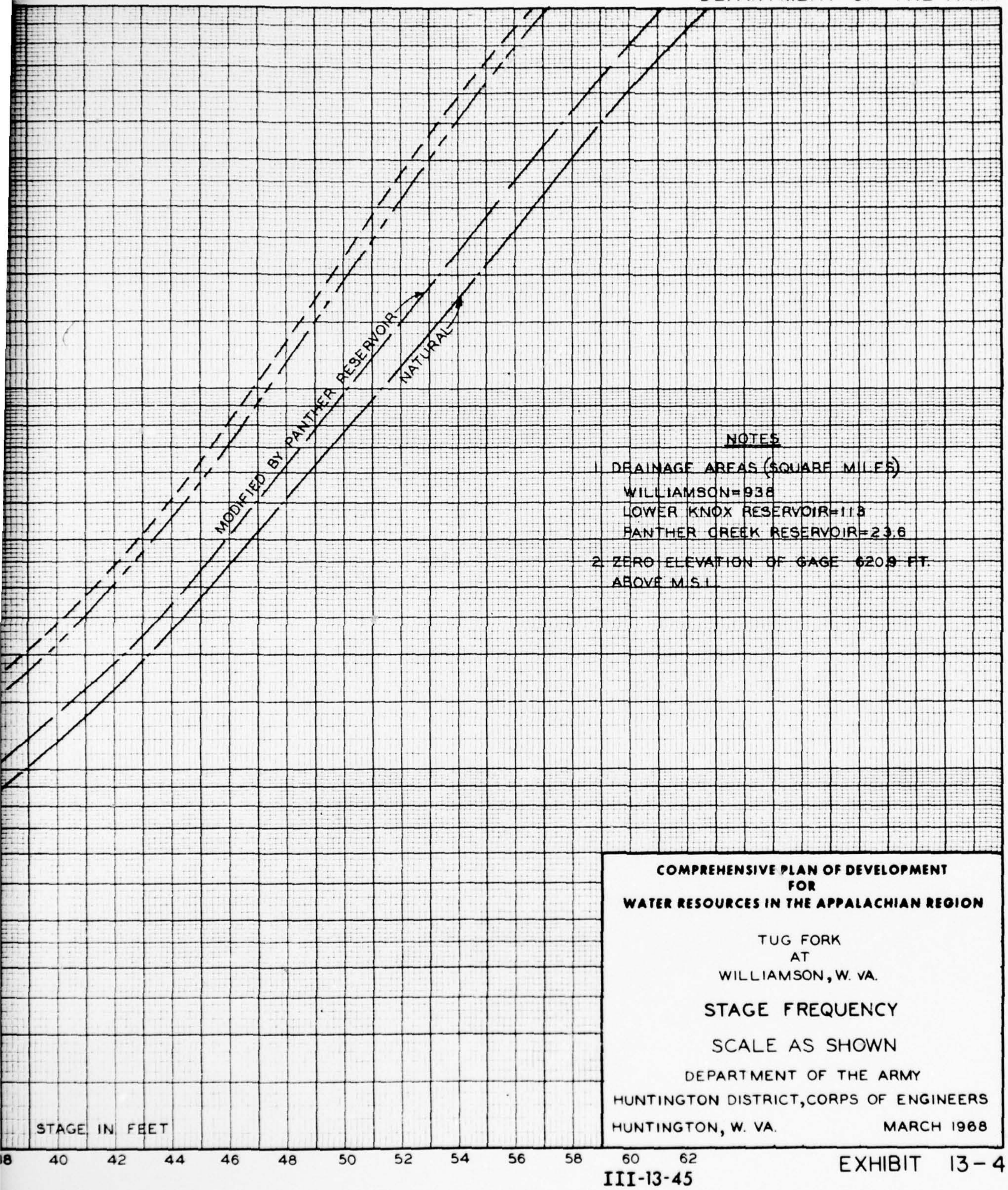
DEPARTMENT OF THE ARMY



COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

TUG FORK
AT
WILLIAMSON, W. VA.

STAGE FREQUENCY

SCALE AS SHOWN

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. MARCH 1968

EXHIBIT 13-4

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TABLE 13-10

PEAK REDUCTION EFFECTED DURING SELECTED FLOODS
ON OHIO RIVER AT ASHLAND, KENTUCKY

Flood	Effective Ohio River reductions attributed to Lower Knox Reservoir	
	Discharge - C.F.S.	Stage-feet
January 1927	107	.007
March 1933	871	.064
March 1936	2,282	.155
January 1937	1,024	.065
January 1939	1,589	.106
April 1940	322	.014
January 1943	646	.042
March 1945	- 786	- .056
April 1948	1,143	.077
January 1950	0	0
January 1952	1,089	.080
March 1955	2,393	.150

Low-flow regulation. Releases from Lower Knox Reservoir, in accordance with the adopted preliminary low-flow regulation plan, would adequately satisfy low-flow requirements along Tug Fork. In addition to meeting Tug Fork demands, releases from Lower Knox Reservoir would supply a portion of the required low-flow augmentation on Big Sandy River below Louisa, Kentucky. Drawdown of the reservoir surface during a drought equal in severity to that of 1930-31 would be approximately 34 feet.

13. GEOLOGIC

Surrounding area description. The proposed dam site and reservoir area lie within the extensively dissected terrain of the Kanawha Section of the Appalachian Plateau. The area is characterized by fine-textured ridges, steep slopes, and moderate relief. Generally, the relief is measured in hundreds of feet.

Steep hillside slopes of sedimentary rock with shallow soil accumulation characterizes the area. The valleys cut in the plateau surface are narrow and meandering, however many of the streams like Knox Creek may be described as approaching early maturity. Some side cutting and scant flood plain deposits exist. This is true on Knox Creek as well as Lower Elk Creek and Turkey Creek, the principal tributaries nearest the dam site. The high ridges in the area slope gently northwest and average 1,650 to 1,700 feet, m.s.l., in elevation. Knox Creek is incised deeply in the plateau and flows in a channel at elevation 730± at the site. The stream gradient is

approximately 20 feet per mile through its middle and lower reaches. Narrow flood plain deposits exist on alternate sides of the stream throughout most of its length.

Area geology. The rocks which outcrop and underlie the basin area consist principally of clastic sedimentary strata, sandstones, shales and siltstones with numerous commercially important coal seams and occasional thin limestones. They represent the Upper (Kanawha group) and Middle (New River group), Pottsville series, (Kentucky Breathitt Formation) Pennsylvanian age. For clarity, the discussion and exhibits will generally use the West Virginia names even though the site is in Kentucky. The terminology of both states is used in some places for correlation with published reports. In this section, the sandstones predominate and the shales are of both the cemented and compaction type. Some of the richest coal seams in the Eastern Coal Basin of Kentucky and West Virginia occur in this region, namely the Lower War Eagle and Campbell Creek or No. 2 Gas and Alma horizons. Extensive strip mining and/or drift mining is pursued in these outcrops.

The bedrock dips gently, almost imperceptably, northwest in this area at a rate of 0° - 46'. This monoclinal surface is interrupted by only minor or secondary folds of little significance. Examples of these low structures with northeast-southwest axes are the Lick Creek syncline and Williamson anticline located 13.0 and 14.5 miles northwest of the site, respectively. A vertical fault of some import, the Warfield Fault, whose axis trends northeasterly, passes 23.7 miles north of the site. Displacements of as much as 100 feet have been noted along this fault and severe rock displacements are not uncommon. This structure is believed to be of Permian Age and the product of deformation whose effects on the strata throughout this area may be significant particularly with respect to jointing.

General project description. The Lower Knox Creek dam site is located approximately 0.4 mile above the stream's confluence with Tug Fork in Pike County, Kentucky. The dam site is situated in a horseshoe bend of the creek in a remote area. The nearest town is Devon, West Virginia, 0.3 air mile north of the site. Access to the area is difficult and principally by unimproved dirt road.

Subsurface investigations. No subsurface investigations were conducted in connection with this site. The information contained in this report was obtained from published and unpublished geologic reports, field reconnaissance and personal interviews with local residents, mining interests and state geologists.

Site geology. The bedrock which underlies the steep abutment slopes at the site consists of sandstones and shales with some associated coal beds. Stratigraphically, they represent the Norton Group of the Breathitt Formation. Within the limits of the proposed top

of dam elevation at 960, the bulk of the strata from drainage to the top of dam consists of sandstone or sandy materials, generally massive in character and cliff forming in topographic expression. A generalized geologic section has been constructed for the dam site area which has an accuracy vertically of 5± feet. This section is shown on exhibit No. 13-5. The basis for the stratigraphy shown is the reference elevation on the "Splash Dam" of Virginia-Kentucky or "Glenalum Tunnel" coal bed of West Virginia which outcrops at elevation 773. Field reconnaissance of the site in exposed areas supports the character, general thicknesses and types of bedrock shown on this section. The limestone marker at elevation 870 was not identifiable at the dam site.

Overburden is thin or absent on the dam abutment slopes. The formations are rather resistant to disintegration and the topography indicates soil removal keeps pace with its derivation from the parent rock. Most of the soils that cover the area are sandy in character. The Lower Knox channel proper appears to be filled with alluvial silts, clays and coarsely granular materials. The characteristics of the stream are such that it is reasonable to assume from the valley width and stream gradient that rock exists at shallow depths beneath the stream.

The sandstone which outcrops at drainage and extends to elevation 760 in the abutments is the Lower Gilbert Formation of West Virginia. Inasmuch as this formation is the critical member for any type of dam and of vital importance for a gravity dam, special efforts were devoted to establishment of its thickness. Outcrops of the Gilbert formation in the area at Devon, Woodman, Glen Alum Junction and Wharncliffe, which locations bracket the dam site, suggest that the thickness will exceed 50 feet at this location. As shown on the geologic section, this would appear to afford an excellent situation for either a rock fill embankment or gravity dam. It is emphasized that in the absence of borings neither the lithology, competence, nor thickness of this sandstone can be established firmly. An interval of approximately 20 feet of coal, underclay, and shale underlies the Gilbert formation in this area so that if either the bedrock profile or estimated formation thickness are in error, the adequacy of the site for a gravity dam is questionable.

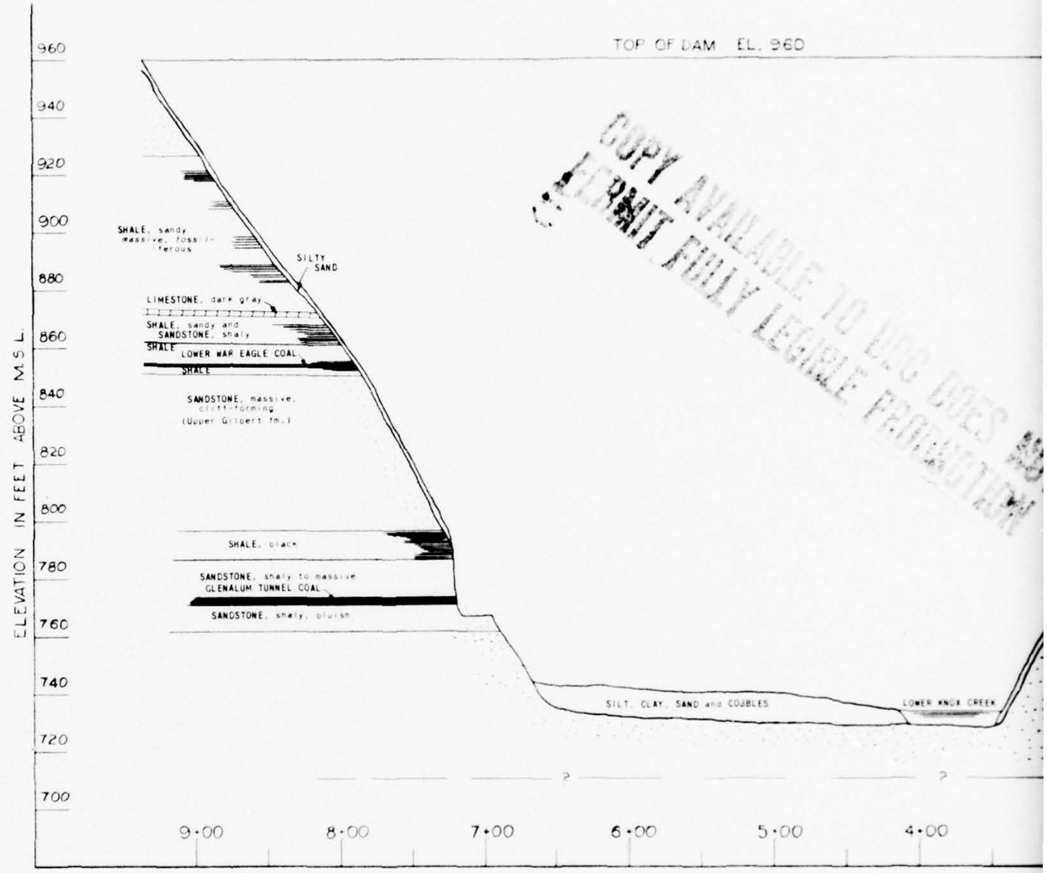
The abutments would be composed of the formations shown on the geologic section. The principal treatment would consist of trimming the vertical to overhanging rock ledges and filling or excavating the small coal mines. Treatment of these openings is planned beneath the entire embankment if that type dam is built or open excavation and backfilling for a gravity structure. A double line grout curtain beneath any dam chosen is recommended.

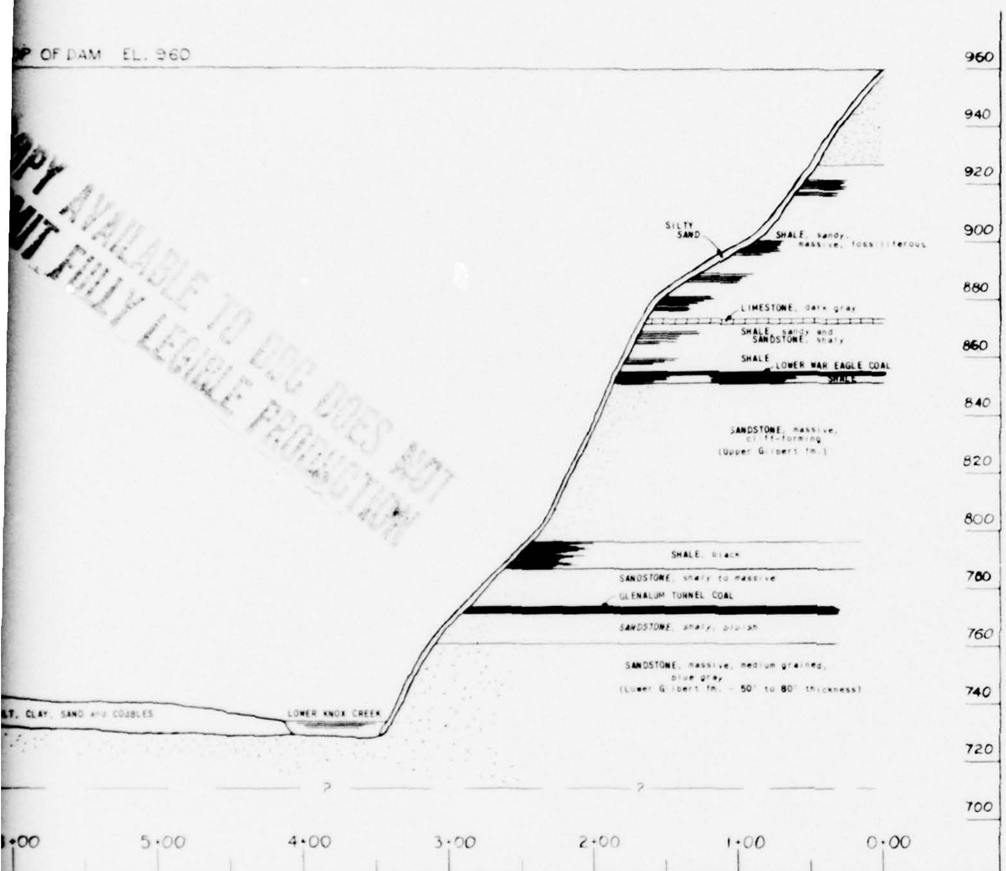
At elevation 925, the spillway crest will be founded near the contact of the Eagle Shale with the Grapevine Sandstone. As the

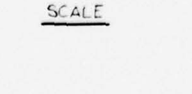
inferred stratigraphy for the spillway shows, most of the excavation will consist of sandstone with two substantial shale beds. The character of the rock and depth of weathering for this area indicate that steep rock cuts will be satisfactory and the bulk of the excavation will be suitable for embankment shell fill. Both the shale and sandstone are of a durable nature so that lining through the spillway will not be required. Only a very thin veneer of soil overlies the spillway area. A geologic spillway section is shown on exhibit No. 13-6.

A tunnel with an average invert elevation at approximately 743 will be driven entirely through the Lower Gilbert Sandstone as shown on geologic section, exhibit No. 13-7. Being both hard and commonly massive, this formation will afford excellent tunneling conditions. The shallow depth of severe weathering disclosed in artificial cuts in the area suggest that shallow embedment and steep rock slopes may be excavated for the portal areas. The roof loads in the tunnel will be very small, and conventional rock bolting will provide adequate support during excavation. Foundation conditions for the intake tower and outlet channel structures are anticipated to be excellent. A double row of radial grout holes will be provided for seepage cutoff around the disturbed rock periphery of the tunnel bore.

Reservoir condition. Inasmuch as coal mining has been of historical importance in the Knox Creek Basin, this activity represents the most serious potential reservoir leakage consideration. Some of the richest coal beds in the basin occur in the bedrock of this area. Extensive drift mining and strip mining have been prosecuted. Within the Knox Creek Reservoir pool area, below top of dam, the only coal seam of any consequence above drainage is the Splash Dam or Glenalum Tunnel horizon. This coal is shown on the geologic section at the dam at elevation 773. The Glenalum Tunnel coal and accompanying sediments include the entire interval between the Upper and Lower Gilbert sandstones. At Glenalum Tunnel, the type locale, this formation is 30 feet thick with only 3'6" of coal. Often the coal is badly split. Since some mining in this seam has occurred, it became vital to determine the extent of this activity. Consultation with the Kentucky Geological Survey and Department of Mines disclosed that no mine maps exist indicating extensive mining in the Glenalum Tunnel or Splash Dam seam. Additional information was derived from conversations with U.S.G.S. geologist William Outerbridge who conducted the field mapping of this quadrangle in 1966-67. Further data were obtained from interviews with mining and land companies who have been active in the Knox Creek area. From these sources and field examination, it can be concluded that: (a) the mining in the Glenalum or Splash Dam seam at the dam site represents shallow domestic exploitation, (b) the mining at Woodman in this bed, while more extensive, did not penetrate the drainage divides to adjacent streams or to the Tug Fork Valley. While none of the mines


TOP OF DAM EL. 960
ELEVATION IN FEET ABOVE M.S.L.
960
940
920
900
880
860
840
820
800
780
760
740
720
700
SHALE, sandy massive, fossiliferous
SILTY SAND
LIMESTONE, dark gray
SHALE, sandy and SANDSTONE, shaly
SHALE
LOWER WAR EAGLE COAL
SHALE
SANDSTONE, massive, cliff-forming (Upper Gilbert fm.)
SHALE, black
SANDSTONE, shaly to massive
GLENALUM TUNNEL COAL
SANDSTONE, shaly, bluish
SILT, CLAY, SAND and COBBLES
LOWER KNOX CREEK
?
?
9+00
8+00
7+00
6+00
5+00
4+00





SCALE

COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

LOWER KNOX CREEK

GEOLOGIC SECTION – DAM

SCALE

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Date:______

III-13-51. EXHIBIT 13-5

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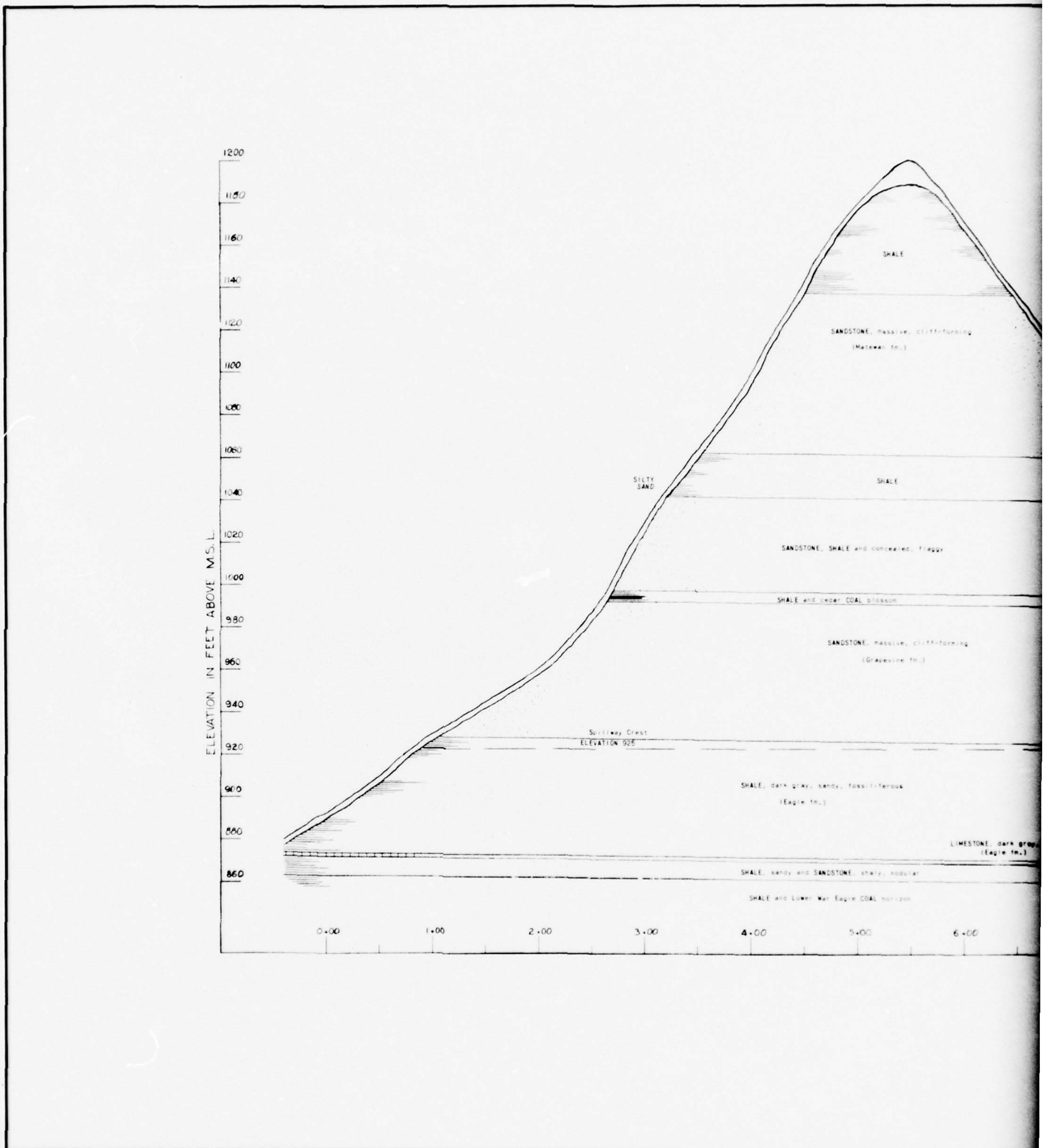

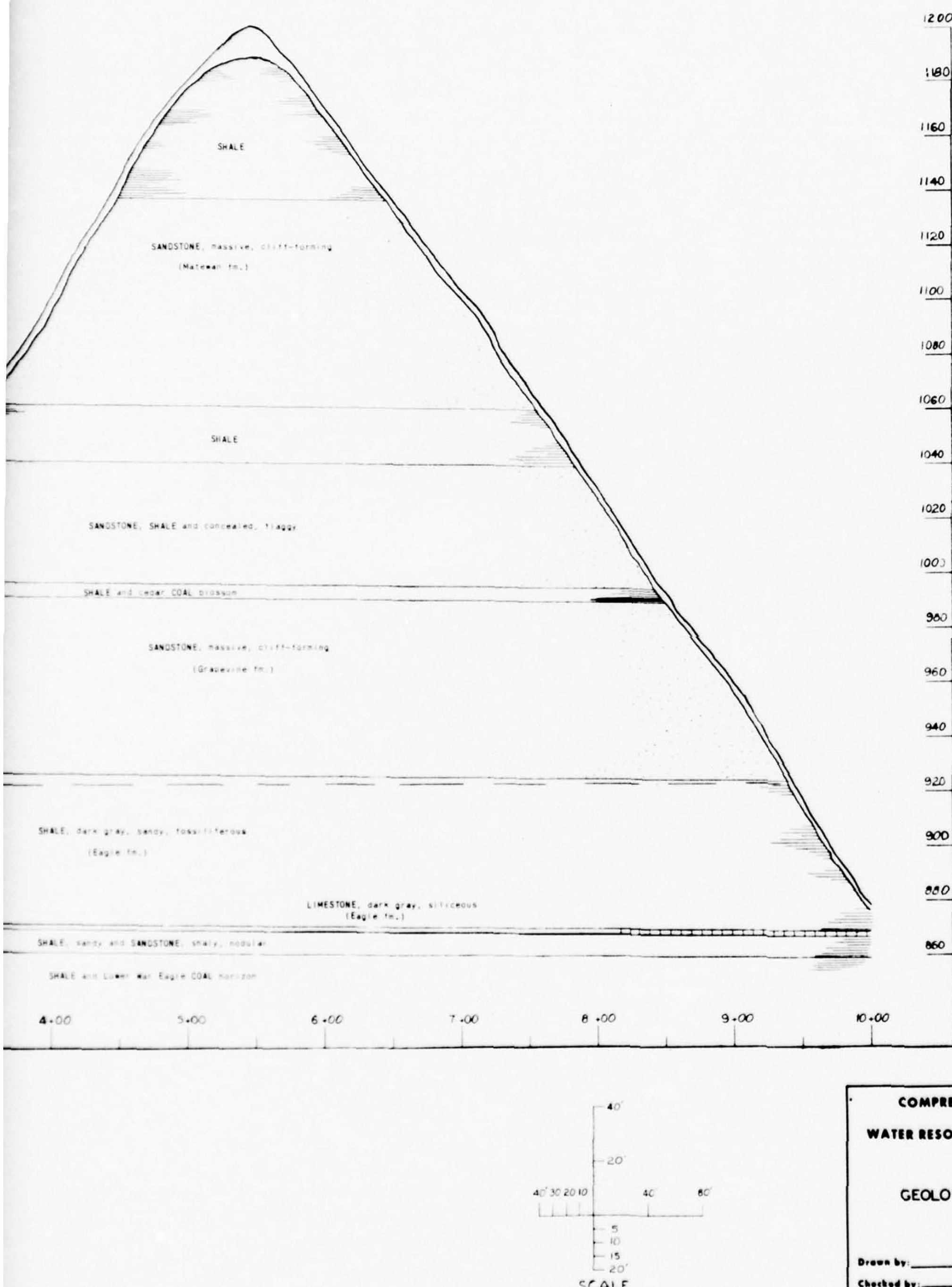

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

LOWER KNOX CREEK

GEOLOGIC SECTION - SPILLWAY

SCALE

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EXHIBIT 13-6

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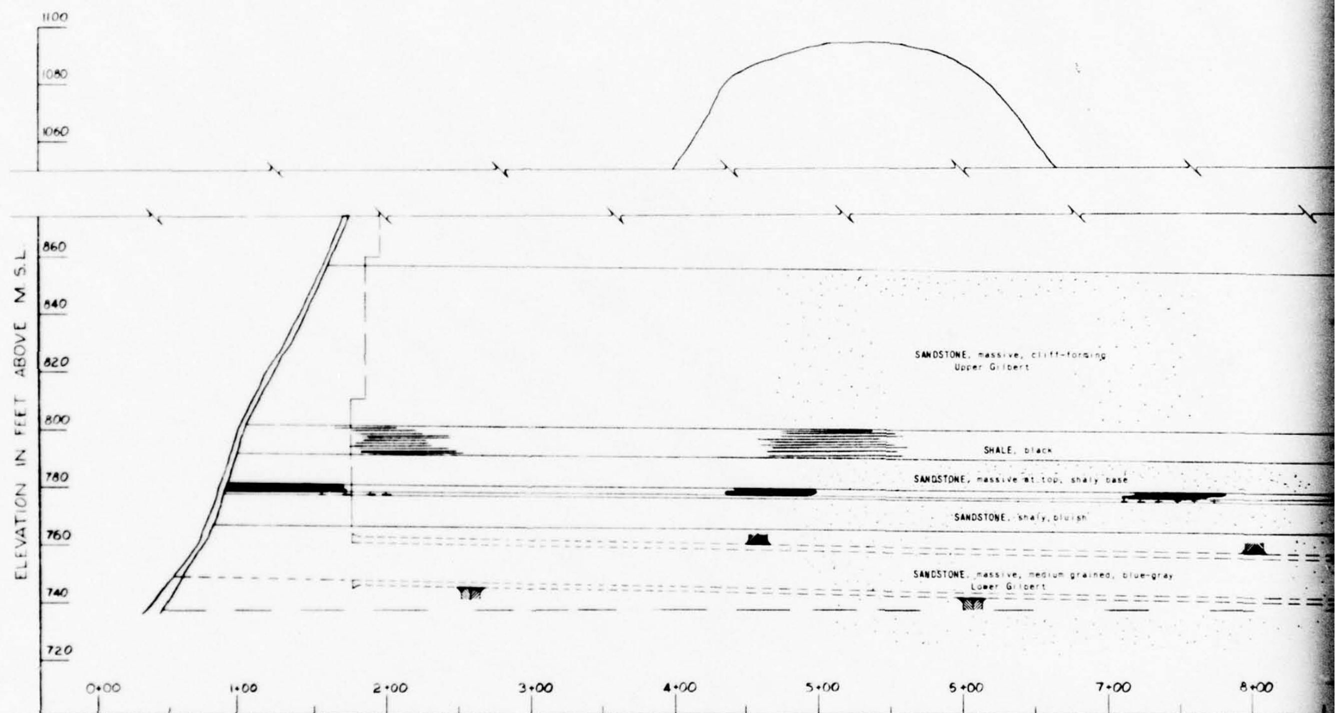

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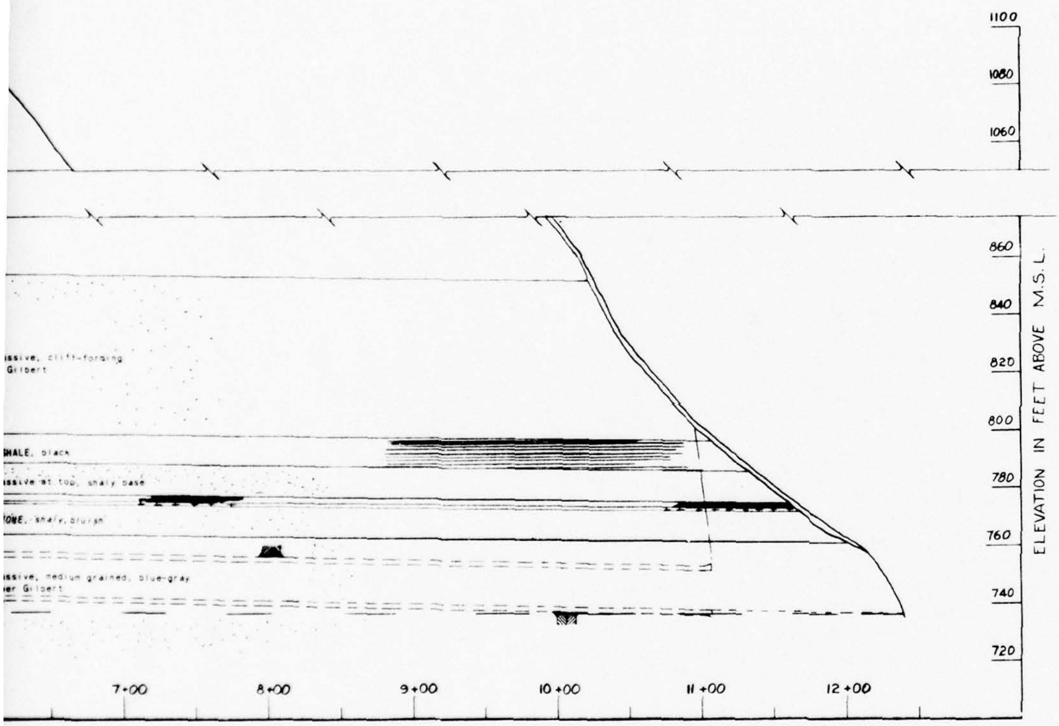

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

LOWER KNOX CREEK

GEOLOGIC SECTION - OUTLET WORKS

SCALE

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were explored, the total data derived from all the sources support one another that large scale mining in the Splash Dam seam has not occurred.

Elaborate drift mining has been conducted in the area in the Pond Creek or Warfield horizons at approximate elevation 1350 and strip mining in the Upper Elkhorn or Alma horizon at approximate elevation 1500. Except for pollution from mine waste, this activity will not affect the reservoir.

It can be further stated that no mining activity of coal seams below drainage has occurred in this area.

Depending on the type of dam selected, some remedial treatment of the mine openings at the dam site will be required. As stated previously, this work will be required for foundation design only; leakage is not anticipated to be a factor. Open excavation or back-filling will be accomplished as appropriate.

Construction materials. No specific investigations have been conducted with respect to construction materials. Some information is apparent however, based simply on the geology and topography of the area. For an embankment type dam, the rock excavation from the spillway will be usable and of good quality. As presently proposed, this excavation will not produce a sufficient quantity of material. Rock borrow from nearby sandstone outcrops can be supplied from a quarry.

A casual examination of the soils in this area and consideration of their derivation from the parent rock discloses that cohesive soils do not exist in usable deposits in the area. Construction of an impervious core type embankment is not likely to be competitive. Deposits of granular materials are common within Knox Creek and along Tug Fork. The degree of contamination of these terraces and bars with organic material, coal and other debris is unknown. Processing would undoubtedly be required to use these deposits.

Mineral resources. The principal mineral resource of the basin is coal. It has been of significance in the past and will no doubt continue. Mining in the thinner seams may be prosecuted in the future using new mining technology.

Timbering. Timbering was exhaustively conducted in this area near the turn of the century. Most, if not all, of the virgin stands have been removed. No significant operations are now conducted.

Conclusion. From the geologic viewpoint, it is concluded that either a rock embankment or concrete gravity dam are feasible for this

site. Only detailed foundation investigations will determine which type is more suitable for the existing foundation conditions. In spite of the coal mining activity which has occurred, a watertight reservoir can be developed without elaborate sealing of openings.

14. STRUCTURAL

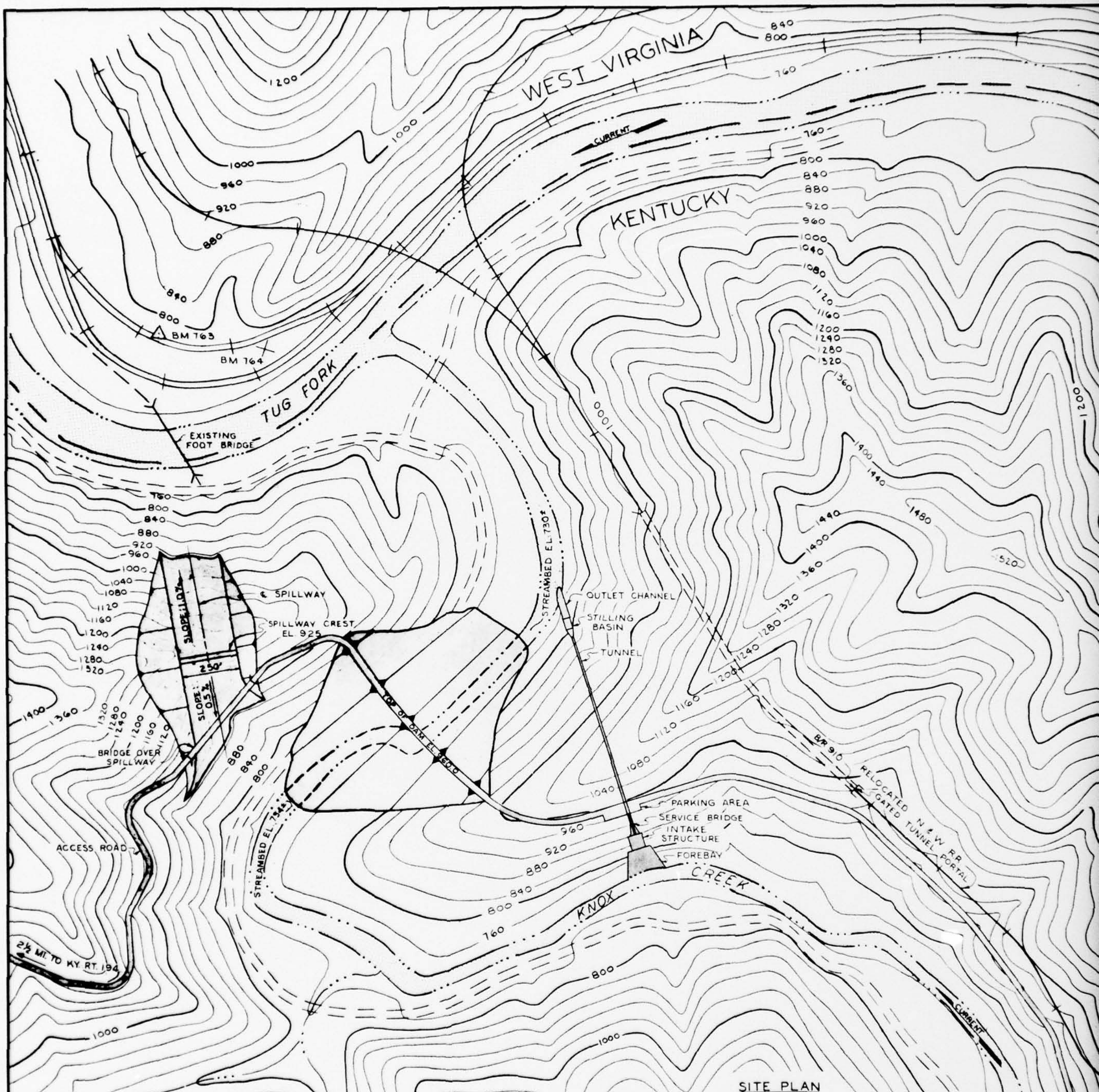
Investigation of site. For the purposes of this survey, investigations were limited to a visual reconnaissance of the site supplemented by geological research. No foundation borings were drilled, no materials were sampled or tested, and no site mapping surveys were made.

Characteristics of site. The site is located near the mouth of Knox Creek. The stream meanders sharply, and the frequency of meander bends limits the space available for construction of a dam. The valley is narrow with relatively steep valley walls. The geologic column is predominantly sandstone with some beds of shale and seams of mineable coal, at least one of which has been mined at the site.

Types of dams studied. The proposed dam will have a height of approximately 228 feet from streambed at elevation 732 to its top at elevation 960. The site is potentially suitable for three principal types of dams: a rockfill embankment dam with a central impervious core, a rockfill embankment dam with an asphaltic concrete membrane on the upstream face, and a concrete gravity dam. Engineering studies, including preliminary designs and cost estimates, have been made for all three types. The proposed arrangement and preliminary design for the selected embankment dam are depicted on Exhibits Nos. 13-8 and 13-9.

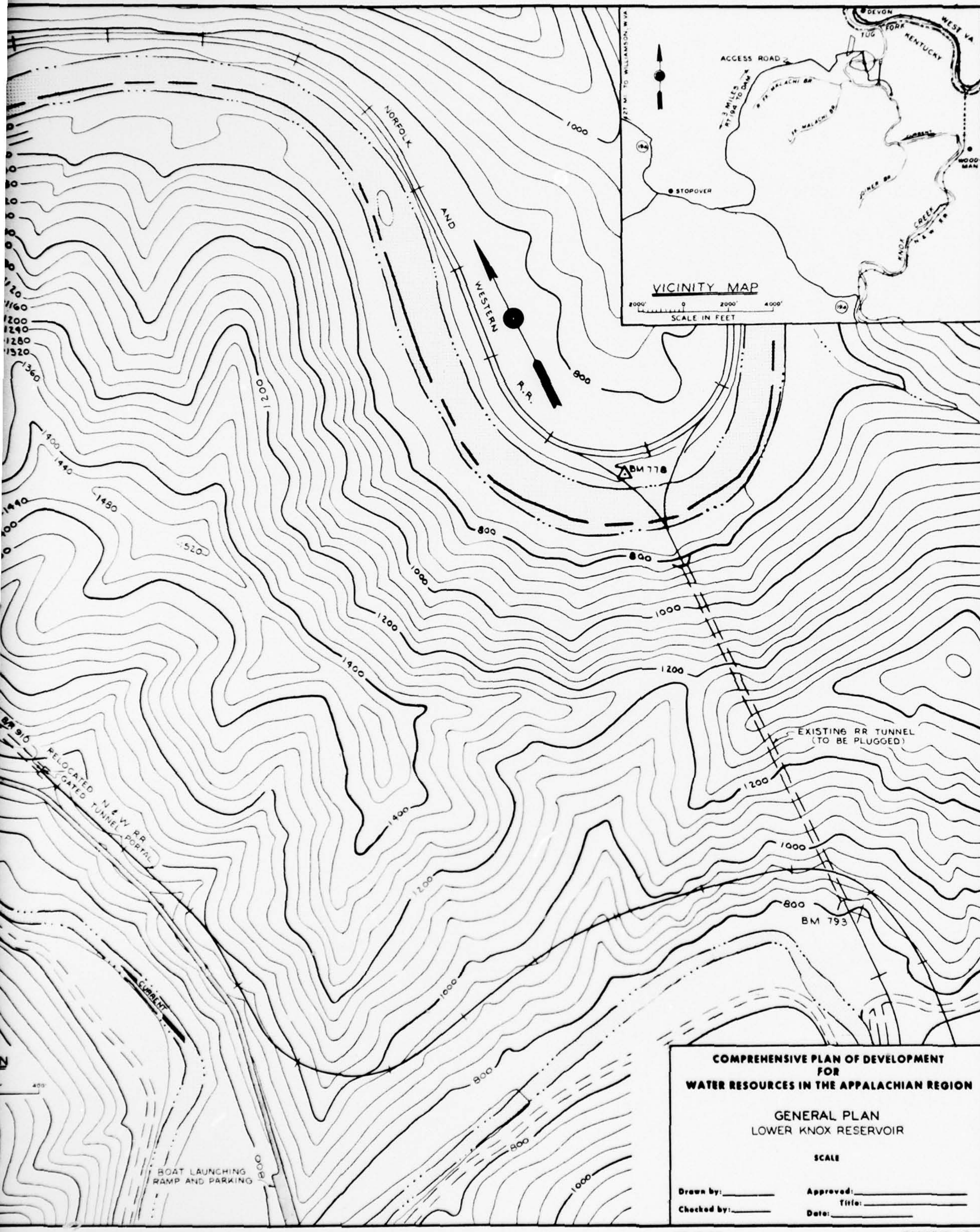
Selected type of dam. The limited scope of investigations made in connection with this survey do not provide sufficient data about the geology and geometry of the site, and the characteristics of construction materials available locally, to warrant a firm decision on the type of dam appropriate for construction at the site. Comparison of the cost estimates for the three types of dams studied indicates that both embankment type dams offer substantial economies over the concrete gravity dam. Also, the estimated costs for the two embankment type dams do not differ appreciably. Accordingly, the rockfill embankment type dam with manufactured impervious core has been selected for the purposes of this survey. The selection is made on the basis that a rockfill dam with a central impervious core offers the advantage of freedom from a maintenance during requirement drawdown. The membrane embankment type dam is an acceptable alternative in the event detailed materials explorations and tests yield results unfavorable to impervious core manufacture.

Rockfill embankment dam with central impervious core. The principal structures are the dam; a tunnel-type outlet works located in the



WEST VIRGINIA
KENTUCKY
TUG FORK
CURRENT
EXISTING FOOT BRIDGE
BM 763
BM 764
℄ SPILLWAY
SPILLWAY CREST EL 925
SLOPE 1:1.0
SLOPE 0.5%
250'
BRIDGE OVER SPILLWAY
TOP OF DAM EL 1060.0
STREAMBED EL 730±
STREAMBED EL 754±
OUTLET CHANNEL
STILLING BASIN
TUNNEL
PARKING AREA
SERVICE BRIDGE
INTAKE STRUCTURE
FOREBAY
KNOX CREEK
ACCESS ROAD
2½ MI. TO KY RT. 194
RELOCATED N & W RR
RELOCATED TUNNEL PORTAL
BOAT LAUNCHING RAMP AND PARKING
SITE PLAN
SCALE IN FEET

2



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

GENERAL PLAN
LOWER KNOX RESERVOIR

SCALE

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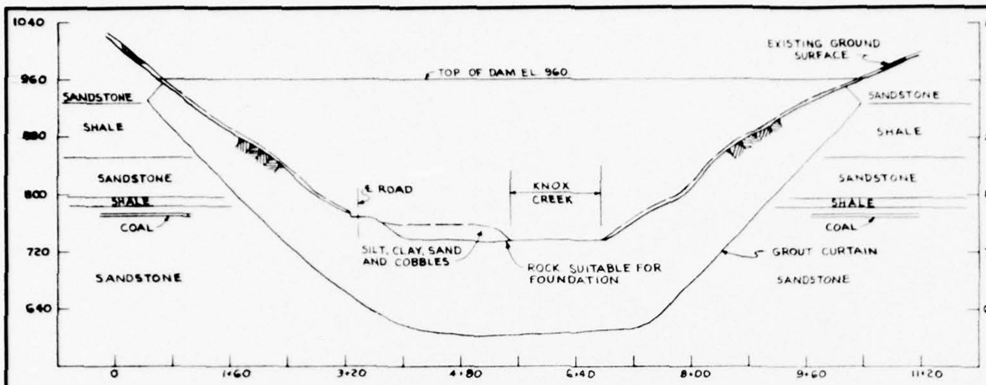
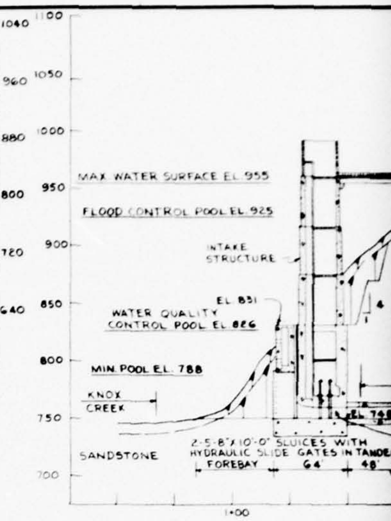
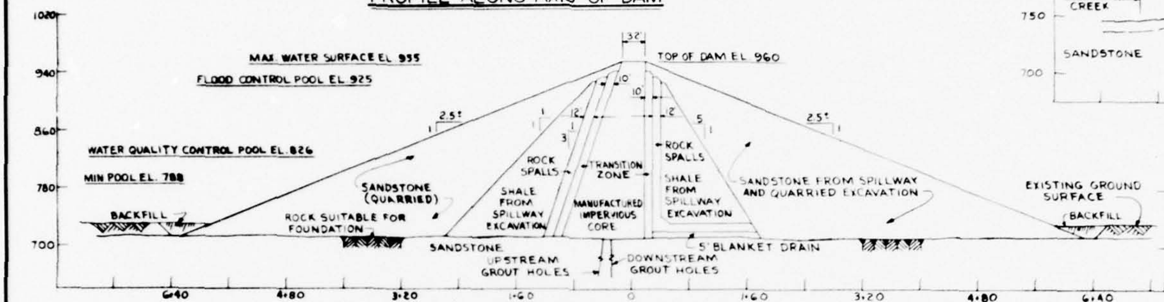
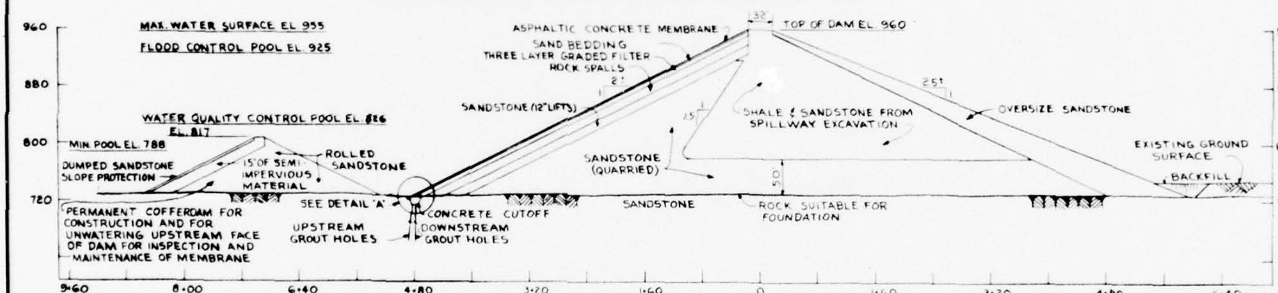


PROFILE ALONG AXIS OF DAM

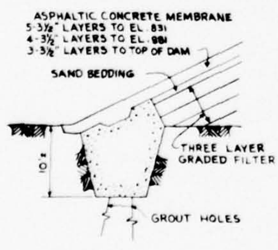




TYPICAL DAM SECTION
MANUFACTURED IMPERVIOUS CORE ALTERNATIVE

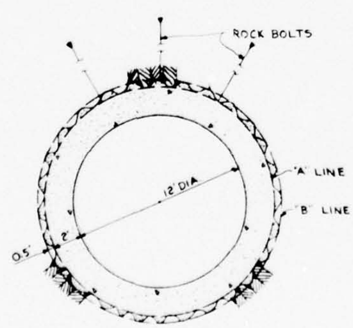


TYPICAL DAM SECTION
ASPHALTIC CONCRETE MEMBRANE ALTERNATIVE



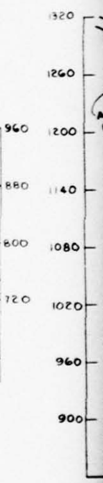
DETAIL 'A'

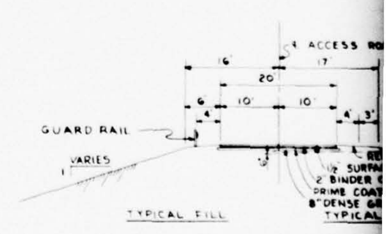
SCALE IN FEET



TUNNEL

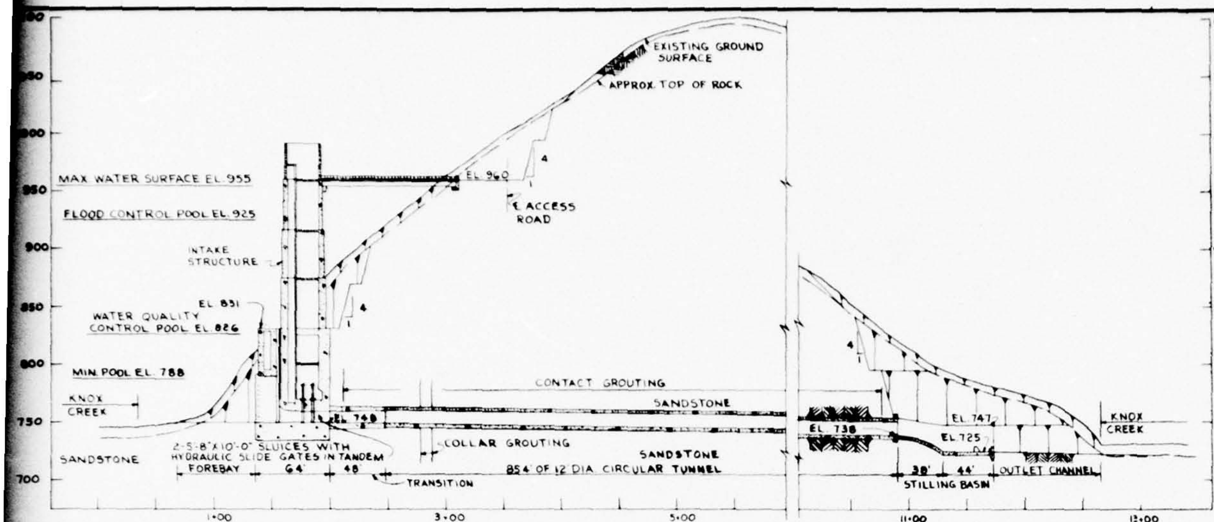
SCALE IN FEET



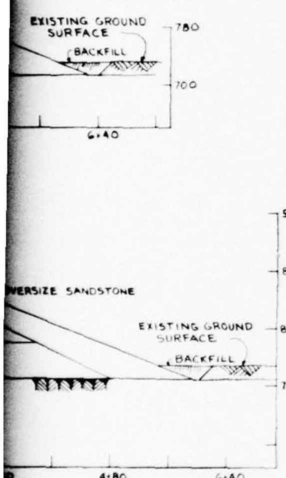


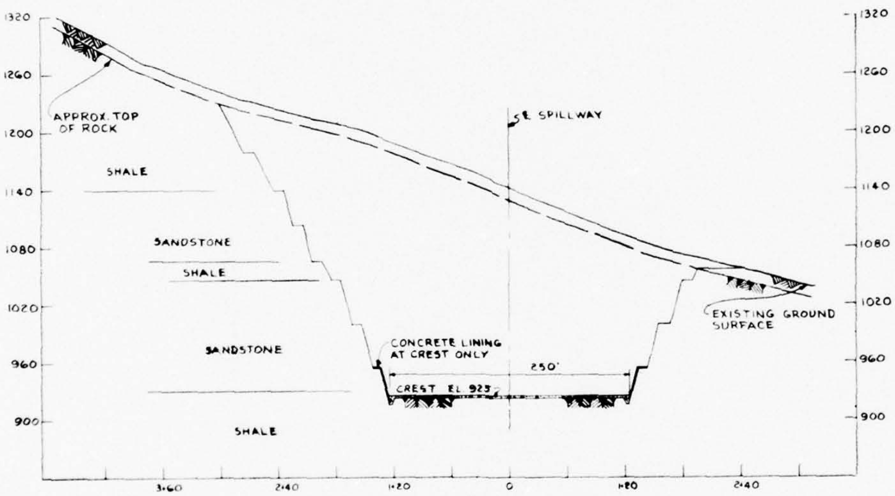
TYPICAL ACCESS ROAD

SCALE IN FEET

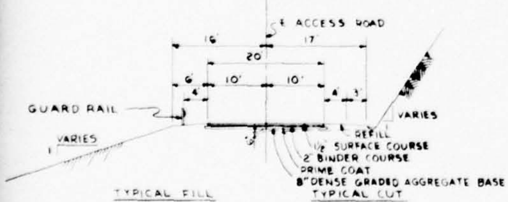


PROFILE ALONG ℄ OUTLET WORKS





SPILLWAY SECTION AT CREST



TYPICAL ACCESS ROAD SECTION

10' 5' 0 10' 20'
SCALE IN FEET

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

DAM PROFILES & SECTIONS
LOWER KNOX RESERVOIR

SCALE

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Checked by: ______ Title: ______
Date: ______

EXHIBIT 13-9

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horseshoe nose of the right abutment valley wall; an uncontrolled, unlined spillway excavated through the ridge of the left valley wall and discharging into Tug Fork about 3,000 feet downstream from the dam; and an access road three miles long connecting the dam and Kentucky Route No. 194. Ample rock of satisfactory quality is apparently available for construction of the embankment shells, but natural materials suitable for construction of the impervious core do not appear to be locally available. The preliminary design, therefore, assumes the necessity for a core manufactured from some combination of processed local materials and imported clays. The practicability and cost of manufacturing a satisfactory core of this type is uncertain, pending accomplishment of a materials exploration and evaluation program. Similarly, the exterior slopes of the embankment will depend upon the strengths of the foundation and the rock to be used in the embankment shells. Since accurate topographic maps are not available, the room available to accommodate flatter embankment slopes is also uncertain. The cost for constructing a rockfill, embankment-type dam with a manufactured impervious core, including the dam embankment, outlet works, spillway, and access road, with an allowance of 30 percent for contingencies, is estimated at $21,000,000.

15. RELOCATIONS

Highway. Kentucky Route 194 connects with Virginia Route 697 at the state line and forms the principal route in the project area. These highways are supplemented by various Virginia secondary roads and Pike County, Kentucky, roads that provide access to residences and mineral holdings. The adopted plan contemplates leaving the through road (Ky. 194 & Va. 697) subject to flooding in the project area. Two roads in the upper reaches of the reservoir would be adjusted to provide above-reservoir access to residences. All other roads now serving as mineral and private access would be abandoned. This plan would be subject to concurrence by the States of Virginia and Kentucky with regard to the through route being subjected to flooding. Proposed highway and railroad relocations are shown on exhibit No. 13-10.

Railroads. The Norfolk and Western Railway owns and operates a single-track railway extending along Knox Creek through the project area and tying into its main line at the confluence of Knox Creek and Tug Fork. One of the major items in the cost estimate for the Lower Knox Creek project was the relocation of this rail line.

The Knox Creek line serves an active coal mining area along the upper reaches of Knox Creek and is the only railway outlet for a major coal producing area in the upper reaches of Levisa Fork and Dismal Creek in Buchanan County, Virginia. Officials of the Railway Company have estimated that approximately one-half of the coal that is handled by their company originates within the area served by the Knox Creek

line. Approximately 50 percent of the coal transported on this line is eastbound for Norfolk, Virginia, with the remainder going to the mid-west and the Great Lakes area.

The plan considered for relocation of the N&W Railway was selected as being the most economical scheme and one that would avoid undue interference with railway operations. The selected route extends along the eastern perimeter of the reservoir area with a tunnel between the Knox Creek and the Tug Fork valleys and connecting lines at maximum acceptable grade into the main line track along Tug Fork. The cost of this relocation was estimated to be about $12,300,000.

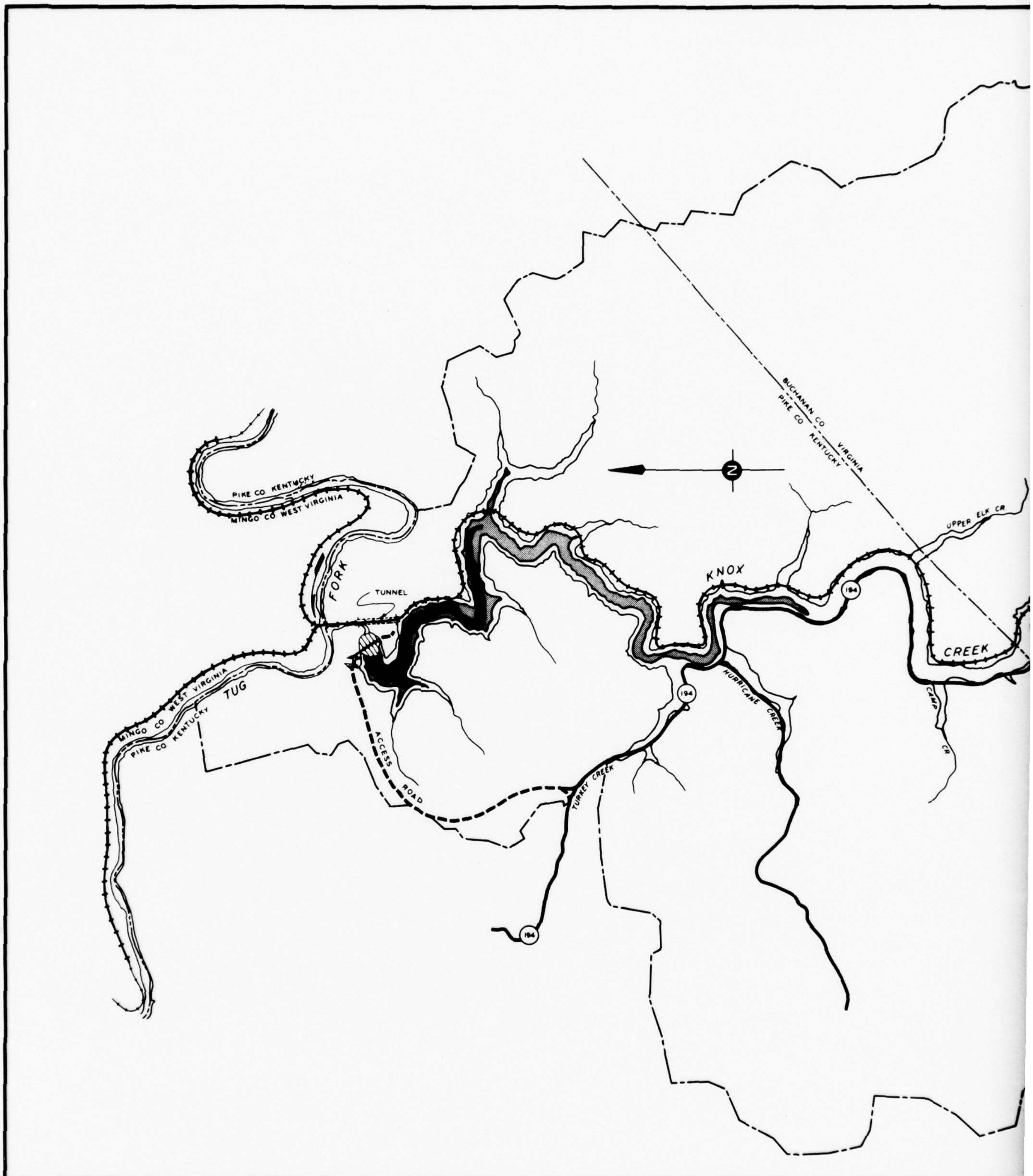
Various possible alternative routes were considered during and subsequent to the survey report. The following tabulation indicates the extent of the proposed relocation and some of the alternate routes considered.

	Approximate length of relocation (miles)	Approximate length of tunnel (feet)
1. Proposed route	8.5	3,000
2. Tug Fork-Poplar Creek (Majestic) - Turkey Creek-Knox Creek	10.5	2,000
3. Left Fork of Peter Creek-Pawpaw Creek-Knox Creek	10.1	4,250
4. Right Fork of Peter Creek-(Phelps) Big Creek-(Dunlap) Levisa Fork	9.6	7,500

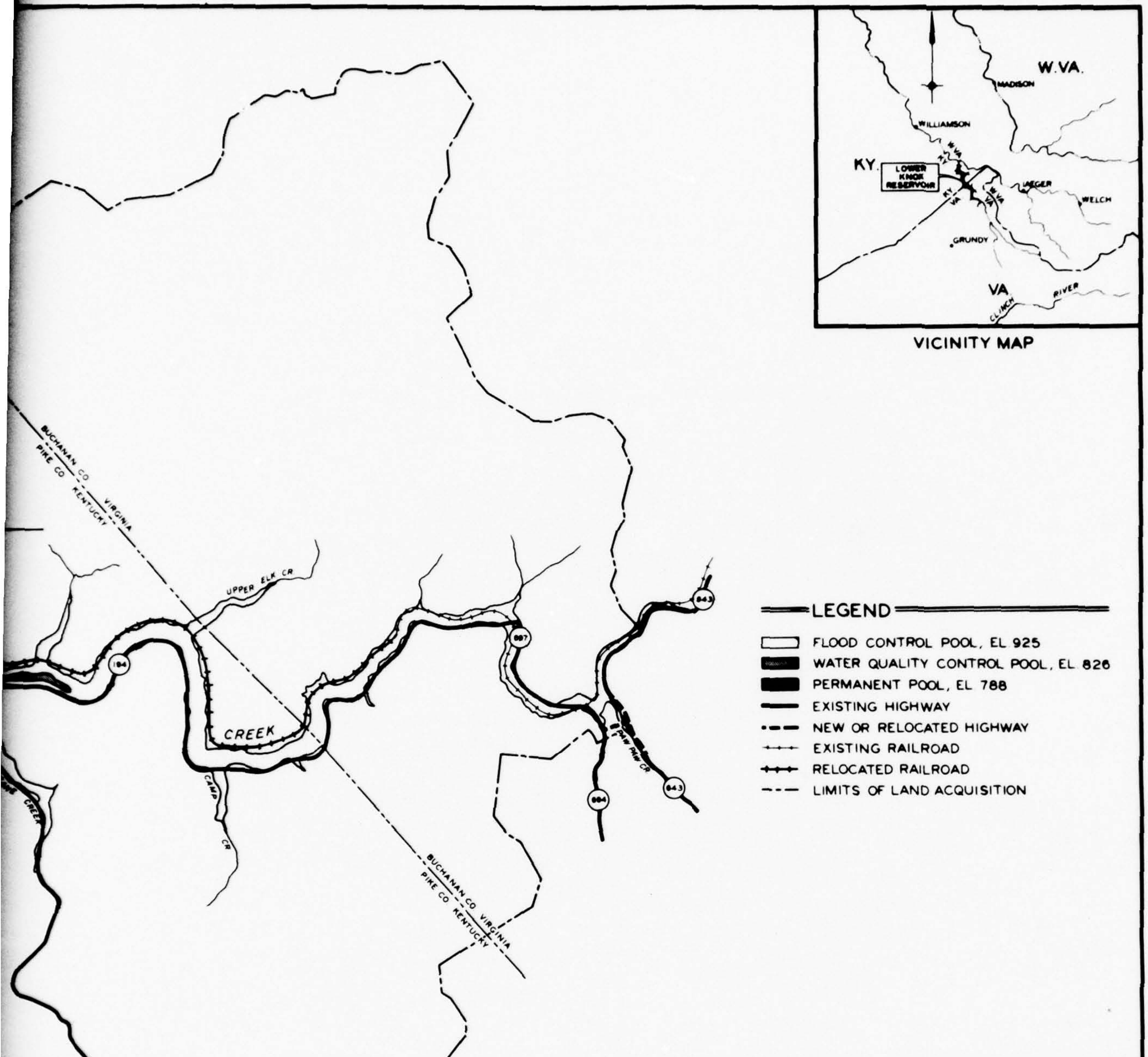
Other possible schemes of relocation would involve utilization of the Levisa Fork Branch Line of the C&O Railroad or the Clinch River-Dry Fork Branch Line of N&W. Use of the C&O facilities would be contingent on completion of the contemplated merger of the two companies. This relocation would be unsuitable to the railroad for eastbound shipment due to the additional mileage that would be involved.

Relocation from Upper Dismal Creek onto the Clinch River line would involve extra shipping distances especially for westbound traffic. Also, much more upstream hauling of loaded trains along Levisa Fork and Dismal Creek would result than is presently necessary since most of the haulage is now downgrade to the main line.

Power and telephone lines. There are a number of power and telephone lines which would have to be raised or relocated. Appalachian



BUCHANAN CO VIRGINIA
PIKE CO KENTUCKY
PIKE CO KENTUCKY
MINGO CO WEST VIRGINIA
FORK
TUNNEL
KNOX
CREEK
UPPER ELK CR
194
MINGO CO WEST VIRGINIA
PIKE CO KENTUCKY
TUG
ACCESS ROAD
HURRICANE CREEK
TURKEY CREEK
CAMP CR



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

LOWER KNOX CREEK

RESERVOIR MAP

SCALE
1 INCH = 4,000 FEET

Drawn by: C.L.F. **Approved:** ______
Checked by: R.G.M. **Title:** ______
Date: ______

EXHIBIT 13-10

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Power Company owns and operates the electric facilities in the Virginia portion of the project area and the Kentucky Power Company owns those in the Kentucky portion. General Telephone Company of the Southeast owns and operates the telephone facilities in Virginia while Southern Bell Telephone Company owns and operates those in Kentucky.

Gas lines. Relocation of gas lines would not be required.

Schools. One school, located in Pike County, Kentucky, at the confluence of Knox and Turkey Creeks, would be affected and would have to be relocated.

Cemeteries. Approximately 20 family and community type cemeteries are within the project area and would be affected to varying degrees.

16. REAL ESTATE

Real estate requirements for the proposed project comprise a total of 18,200 acres. Normal real estate requirements for surface lands were based on a guide taking line located a minimum of 300 feet horizontally from the maximum flood control pool (Elevation 925, m.s.l.) in accordance with current real estate policies. Normal real estate blocking out procedures dictated a design taking line which includes a dam site construction area, rights-of-way for relocated roads and railroads, and a margin of land for shoreline control. Entire properties have been included where private access would be severed by minimum project requirements. Acquisition of reservoir project lands will require the relocation of approximately 210 families.

The basic requirement of 5,050 acres includes 550 acres of railroad right-of-way outside the project boundary needed for relocation purposes. In addition to these requirements, 6,200 acres along the east side and 6,000 acres along the west side of the project would be purchased due to loss of access. Also, 950 acres would be required specifically for recreational development. The additional lands for recreation, at an estimated cost of $85,000, are located generally west of the reservoir.

It is proposed to acquire fee title to approximately 700 acres at the dam site. The remaining 17,500 acres would be purchased with fee title to the surface only; coal, oil and gas interests would be reserved to the owner and appropriately subordinated to project purposes. The approximate limits of real estate acquisition are shown on exhibit No. 13-10.

Mineral interests in the project area demand a considerably greater portion of fee value than do surface interests. With proper regulation, both coal and natural gas reserves can continue to be exploited without interfering with primary purposes of the proposed project. It is therefore proposed to acquire fee title to 700 acres of minerals in the dam site and construction area only. In the

remainder of the project, coal, oil and gas would be reserved or left outstanding and appropriately subordinated. Subordination rights would include, as applicable, the rights to flood and to control location and structures below the vertical guide taking line and in designated recreational site. Strip mining rights would be extinguished, but auger and deep mining would be allowed where it does not interfere with the project or adversely affect the quality of the water.

The acquisition proposed herein has been coordinated with the plan of highway and railroad relocations and with the plan for public use development. Public school properties and cemeteries are considered as relocations items for the purpose of this report.

17. RECREATION

Present recreation opportunity. According to the U. S. Bureau of Outdoor Recreation, the Tug Fork Basin is deficient in camping, picnicking, swimming and boating opportunities. There is an urgent need for suitable day-use facilities. Assuming an increase in the per capita income of the residents, there will be an increasing need for recreational facilities, particularly those that provide for boating opportunities.

Fishery resources on Knox Creek and its tributaries are of low value. Fisherman activity is limited by shallow water and utilization for fishing is considered insignificant. Wildlife resources of the reservoir area are of negligible value. Moderate populations of squirrel and raccoon are found, but hunter use of the area subject to inundation is insignificant.

Lower Knox Reservoir. Construction of the Lower Knox Creek Reservoir would create a potential for provision of an outdoor recreation area capable of satisfying a portion of the existing and projected demand for public use facilities of this nature. Primary considerations of the need and provisions of public-use facilities are predicated on utilization of the project for flood control and water quality control purposes as well as for general recreation and fish and wildlife. The fluctuating pool caused by operations necessary for downstream water quality would not be of a degree that would significantly adversely affect recreation use. It is assumed that the Commonwealth of Kentucky or some other appropriate non-Federal governmental agency, would participate in the cost sharing arrangements necessary under the terms of PL-89-72, the Federal Water Projects Recreation Act, approved 9 July 1965, should the project be authorized.

Factors influencing recreational development. The classic factors influencing recreational use and development that have been generally considered are contributive population, regional economic conditions, extent and type of development in the upstream watershed, project land

and water areas, quality of water, general characteristics of the terrain, existing and proposed access, trends in the public preferences as to types of outdoor recreation activities, and related recreation areas.

Region served. The recreational usefulness of the project is limited by poor access, severe topography, the adverse effects of exploration and exploitation of natural resources, along with the general economic conditions of the region, and the relatively small pool. The park type development is envisioned as serving the Tug Fork region with a primary zone of influence encompassing portions of three West Virginia counties, one Kentucky county and one Virginia county having a total population of about 277,000 according to the 1960 census. A substantial part of the estimated visitation would originate in the Charleston and Huntington-Ashland-Ironton metropolitan area within a 75 mile radius of the project.

Anticipated attendance. The Bureau of Outdoor Recreation, in estimates provided for project formulation, indicated that an estimate of 100,000 recreation days annually could be considered as reasonable. This estimate should also be considered preliminary and is contingent on more detailed studies of the recreation potential of the site. The projected use for project evaluation purposes was assumed to reach full development within the first 3 to 5 years of project life and continue thereafter. Fish and wildlife recreation visitation is estimated to be 7,700 annually by the U.S. Fish and Wildlife Service.

The Bureau of Outdoor Recreation's report is contained in Appendix F and the U.S. Fish and Wildlife Service's report in Appendix G.

Plan of development. Implementation of the plan would provide facilities to accommodate the expected visitation. Eight (8) sites, oriented toward local day-use, would be developed with facilities for sightseeing, picnicking, hiking, fishing, hunting and boating. The proposed development is shown on exhibit No. 13-11.

In accordance with the recommendations of the U.S. Fish and Wildlife Service (1) multiple level outlets would be considered during advanced planning in coordination with the USF&WL, Kentucky department of Fish and Wildlife Resources and the FWPCA: (2) clearing of the reservoir area would be coordinated with the state and the USF&WL; (3) a zoning plan would be investigated in coordination with the State and USF&WL; and (4) all lands not required for project operation and recreation will be available for inclusion in a general plan.

The costs for beautifying various project features have been incorporated into the appropriate items in the detailed estimate of costs. All construction scars, borrow areas and quarries would be restored by landscaping, seeding and planting. Facilities at all recreation sites would be designed to blend with the surroundings and all sites would be suitably landscaped. Access roads and relocations would be designed to accommodate project purposes and in a manner which would not detract from the natural scenery.

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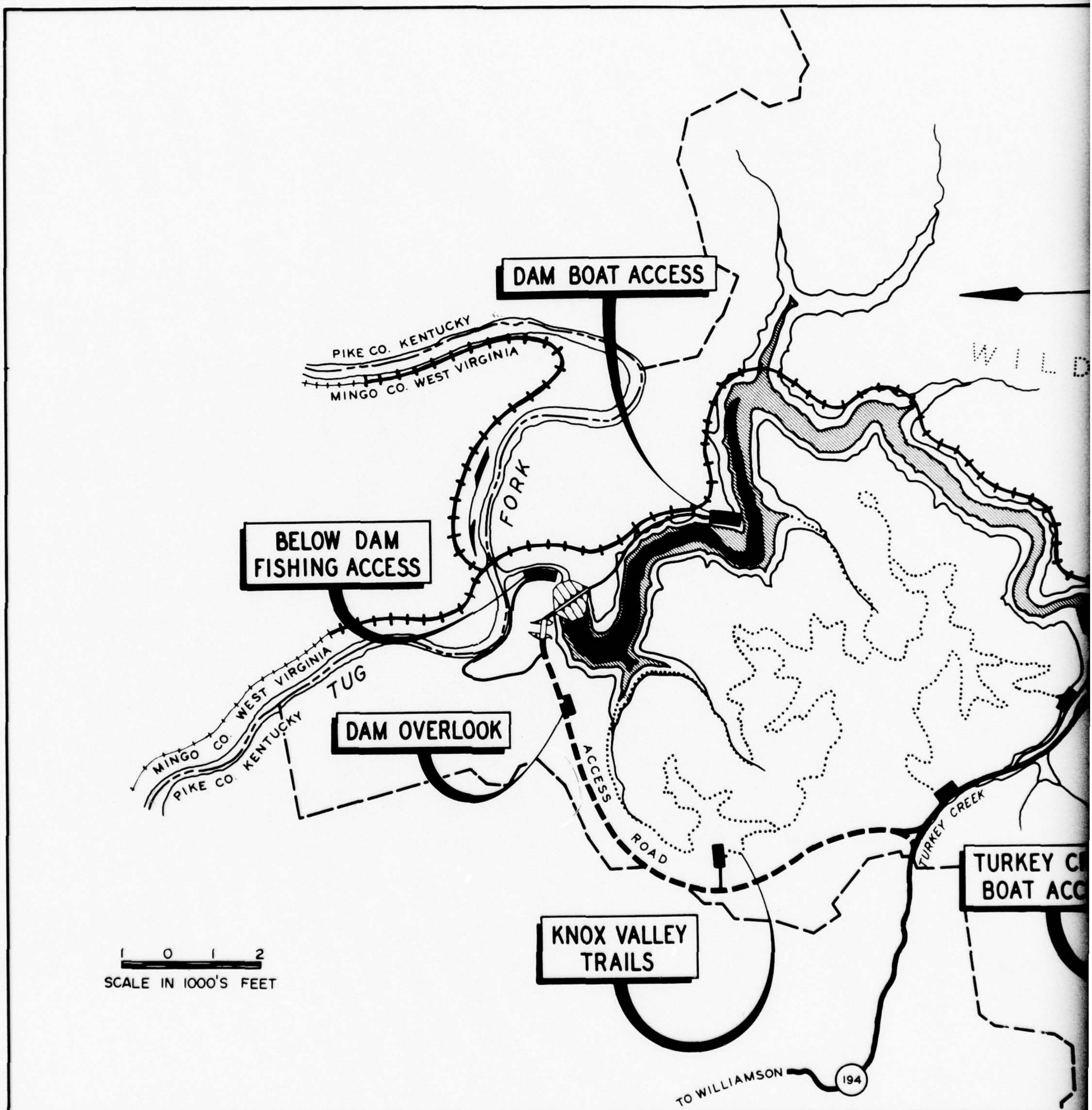

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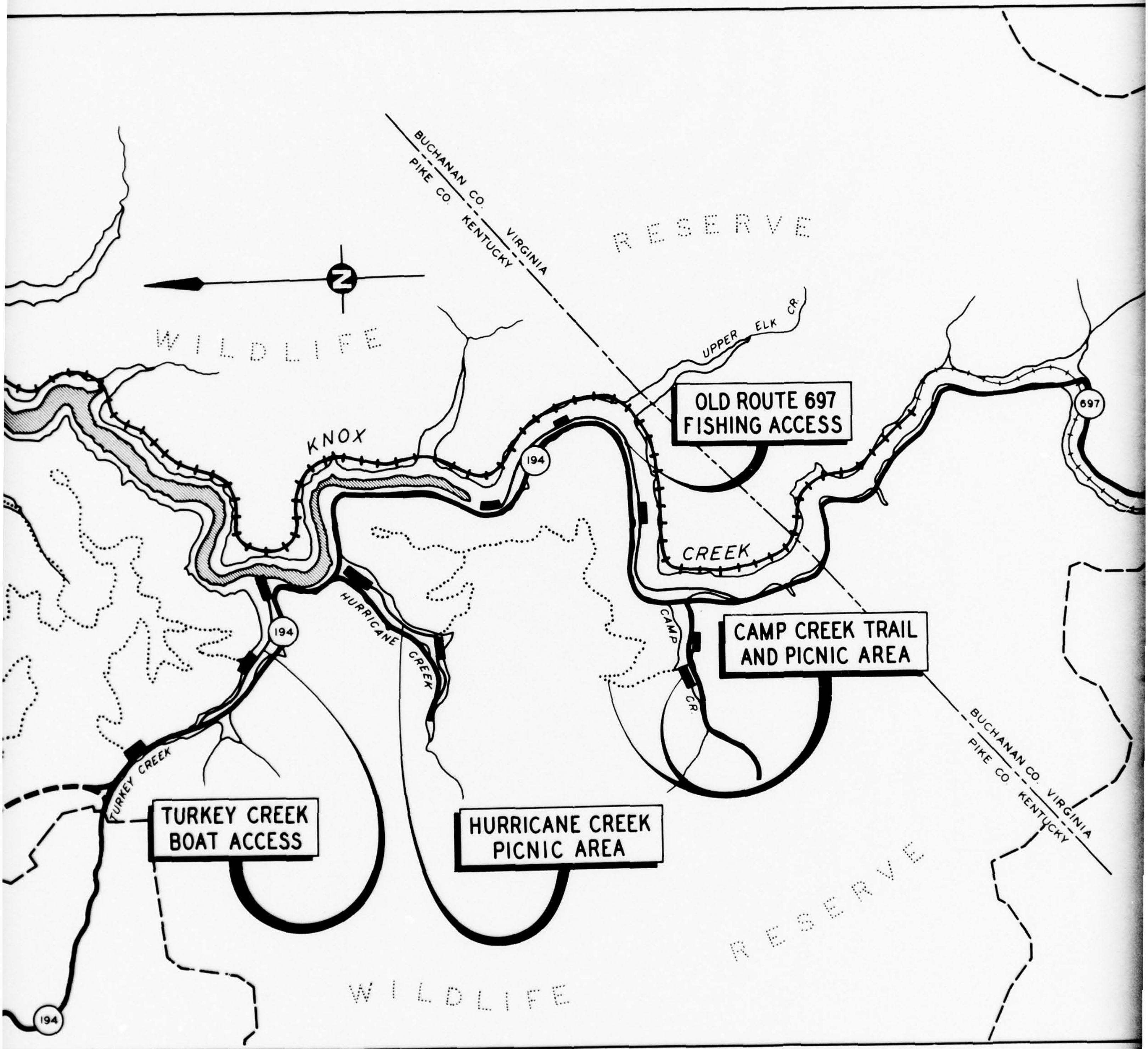
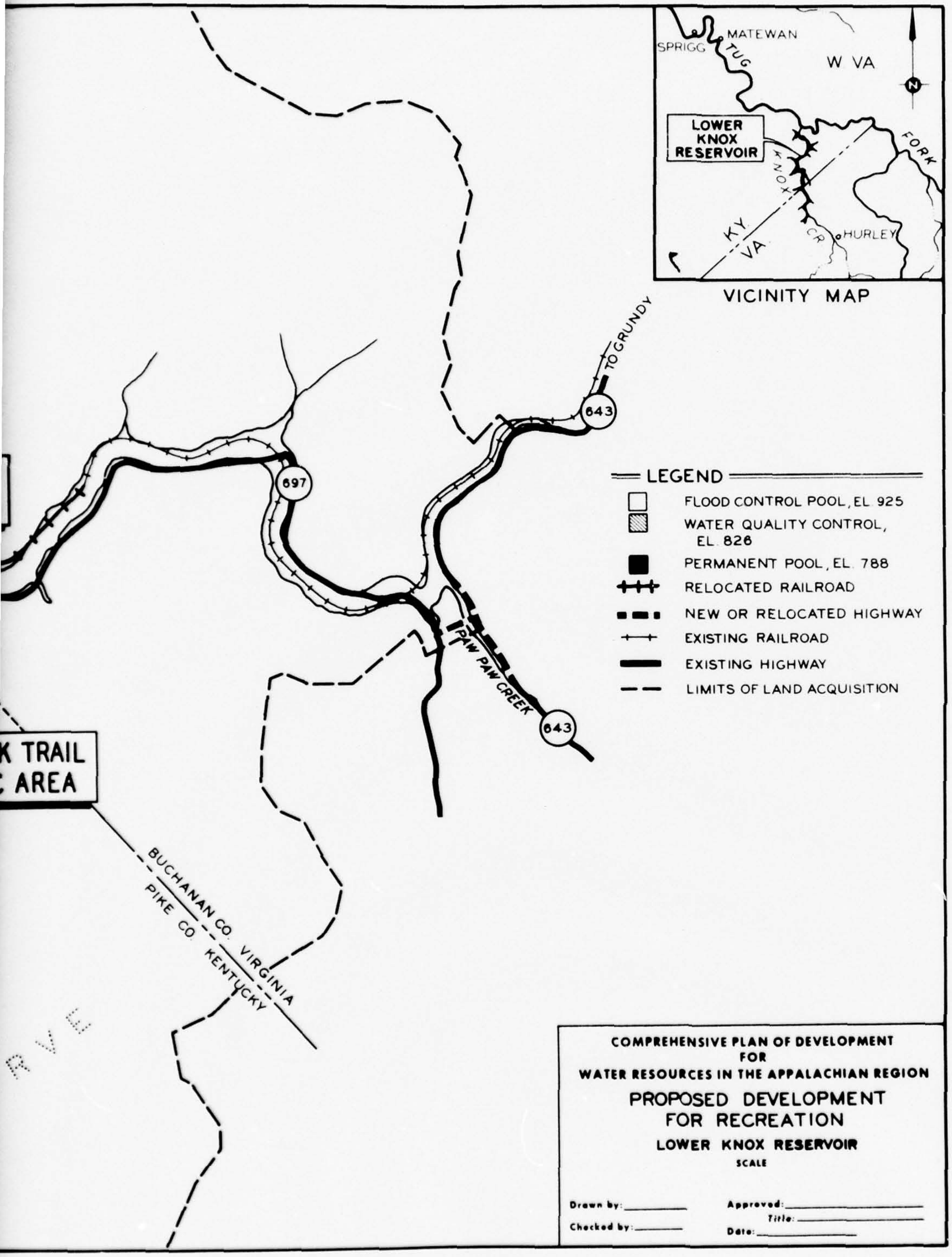


BUCHANAN CO. VIRGINIA
PIKE CO. KENTUCKY
RESERVE
WILDLIFE
UPPER ELK CR.
OLD ROUTE 697
FISHING ACCESS
697
KNOX
194
CREEK
CAMP CREEK TRAIL
AND PICNIC AREA
CAMP CR.
HURRICANE CREEK
194
TURKEY CREEK
TURKEY CREEK
BOAT ACCESS
HURRICANE CREEK
PICNIC AREA
BUCHANAN CO. VIRGINIA
PIKE CO. KENTUCKY
RESERVE
WILDLIFE
194

3



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

PROPOSED DEVELOPMENT
FOR RECREATION

LOWER KNOX RESERVOIR

SCALE

Drawn by:______ Approved:______
Title:______
Checked by:______ Date:______

EXHIBIT 13-11

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SECTION IV - COST ESTIMATES

18. PROJECT COST

The total cost of construction of Lower Knox Reservoir is estimated to be $49,200,000. Estimates of first costs for the reservoir and appurtenant facilities include initial construction, recreation facilities, contingencies, engineering and design, and supervision and administration. Construction costs were based on the layout as shown on exhibits Nos. 13-8 and 13-9 and design considerations discussed in paragraph 14. Unit prices for the cost estimates are based on the prevailing prices for comparable construction in the same general locality as Lower Knox and are adjusted to July 1968 price levels. Contingency allowances vary from 20% to 30% of the feature cost dependent on the rigor of investigations for the particular feature. A summary of capital cost and a detailed estimate of cost for Lower Knox Reservoir are shown on tables 13-11 and 13-12 respectively.

Total investment costs and annual financial costs were developed for Lower Knox Reservoir based on data presented in the cost estimates. Investment costs include construction cost plus interest during construction on the initial investment. Interest during construction for Lower Knox Reservoir was determined using an interest rate of 3.25% for a construction period of four years. Average annual costs were computed on the gross investment using the current Federal interest rate of 3.25% and an amortization period of 100 years. Operation and maintenance costs for the Lower Knox development are based on current costs of similar projects and include costs for major replacement where applicable. Financial and economic annual costs are summarized in table 13-13, and detailed estimates of the annual costs are shown in table 13-15.

TABLE 13-11

SUMMARY OF CAPITAL COSTS

LOWER KNOX MULTIPLE PURPOSE DAM AND RESERVOIR PROJECT
(Based on prices prevailing in July 1968)

No.	Item	Cost	Cost with Items Nos. 7 and 8 distributed
1.	Lands and damages 1/	$ 4,432,000	$ 4,432,000
2.	Relocations	15,800,000	18,490,000
3.	Reservoir	165,000	193,000
4.	Dam and appurtenances	21,000,000	24,570,000
5.	Recreation	1,110,000	1,299,000
6.	Permanent buildings and operating equipment	185,000	216,000
7.	Engineering and design	3,540,000	-
8.	Supervision and administration	2,968,000	-
	Total cost	$ 49,200,000	$ 49,200,000

1/ Includes $85,000 specifically for general recreation.

TABLE 13-12
DETAILED ESTIMATE OF CAPITAL COST

LOWER KNOX MULTIPLE PURPOSE DAM AND RESERVOIR PROJECT
(Based on prices prevailing in July 1968

Item	Unit	Quantity	Unit Price	Amount
LANDS AND DAMAGES				
Fee to surface	Acre	18,200	$ -	$ 840,000
Improvements	Set	210	-	798,000
Subtotal, fee surface and improvements				$1,638,000
Contingencies				409,000
Total, Fee surface and improvements				$2,047,000
Minerals				
Coal				
Fee to Dam Site	Acre	700	-	$ 88,000
Subordinate to Project Purposes	Acre	17,500	-	1,339,000
Subtotal, Coal				$1,427,000
Gas				
Fee to Dam Site	Acre	700	-	$ 8,000
Subordinate to Project Purposes	L.S.	-	-	135,000
Subtotal, Gas				143,000
Subtotal, Minerals				1,570,000
Contingencies				392,000
Total, Minerals				$1,962,000
Administrative Costs	Tract	265	$1,200	$ 318,000
Resettlement costs	Each	210	500	$ 105,000
TOTAL, LANDS AND DAMAGES				$4,432,000

TABLE 13-12 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
RELOCATIONS				
Roads				
Virginia secondary 643	L.S.	-	-	$ 215,000
Virginia secondary 694	L.S.	-	-	34,000
Subtotal, Roads				249,000
Railroad				
Norfolk & Western Railway	Mile	13.6	-	12,332,000
Utilities				
Power lines (relocate & abandon)	L.S.	-	-	33,000
Telephone lines (" " ")	L.S.	-	-	8,000
Subtotal, Utilities				41,000
Schools	L.S.	1	-	22,000
Cemeteries	L.S.	-	-	450,000
Beautification	L.S.	-	-	75,000
Subtotal, Relocation				$13,169,000
Contingencies				2,631,000
TOTAL, RELOCATION				$15,800,000
RESERVOIR				
Clearing reservoir	Acre	135	$ 500	$ 67,500
Boundary marking	Mile	30	2,000	60,000
Subtotal, Reservoir				127,500
Contingencies				37,500
TOTAL, RESERVOIR				$ 165,000

TABLE 13-12 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
DAM AND APPURTENANCES				
Dam and Spillway				
Field Office	L.S.	1	$ -	$ 50,000
Care and Diversion of Water	L.S.	1	-	100,000
Clearing and Grubbing	Acre	60	450.00	27,000
Excavation				
Common	C.Y.	590,000	0.90	531,000
Rock	C.Y.	1,480,000	1.80	2,664,000
Borrow, sandstone	C.Y.	1,650,000	1.50	2,475,000
Embankment				
Manufactured Impervious Core	C.Y.	415,000	6.00	2,490,000
Transition Zones	C.Y.	113,000	3.50	395,500
Rock Spalls	C.Y.	133,000	0.70	93,100
Shale Zones	C.Y.	730,000	0.20	146,000
Sandstone Zones	C.Y.	2,600,000	0.25	650,000
Blanket Drain	C.Y.	50,000	3.50	175,000
Backfill	C.Y.	39,000	0.10	3,900
Foundation Drilling and Grouting	L.S.	1	-	180,000
Anchor Bars Grouted in Place	L.F.	6,000	3.50	21,000
Drill 3" Drain Holes	L.F.	300	4.00	1,200
Concrete Lining at Spillway Crest	C.Y.	1,500	40.00	60,000
Cement	Bbl.	2,400	5.50	13,200
Reinforcing Steel	Lb.	150,000	0.17	25,500
Road Surfacing Across Dam	S.Y.	2,100	10.00	21,000
Guard Rail	L.F.	1,900	4.00	7,600
Railroad Tunnel Plug	L.S.	1	-	150,000
Sealing and Plugging Mines	L.S.	1	-	500,000
Subtotal, Dam and Spillway				$10,780,000
Outlet Works				
Clearing and Grubbing	Acre	2	450.00	$ 900
Excavation				
Common	C.Y.	22,000	1.30	28,600
Rock	C.Y.	44,000	3.00	132,000
Tunnel	C.Y.	6,360	25.00	159,000
Tunnel Grouting	L.S.	1	-	50,000
Rock Bolts (Tunnel)	Lb.	20,000	2.00	40,000
Steel Tunnel Supports	Lb.	90,000	0.35	31,500
Anchor Bars Grouted in Place	L.F.	1,400	3.50	4,900
Drill 3" Drain Holes	L.F.	400	4.00	1,600

2

TABLE 13-12 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Outlet Works (Cont'd)				
Concrete				
Intake Structure	C.Y.	13,600	$ 70.00	$ 952,000
Tunnel and Transition	C.Y.	3,200	55.00	176,000
Stilling Basin Slab and Keys	C.Y.	660	40.00	26,400
Stilling Basin Liner Walls	C.Y.	220	55.00	12,100
Cement	Bbl.	20,000	5.50	110,000
Reinforcing Steel	Lb.	1,800,000	0.17	306,000
Waterstops, Rubber	L.F.	58,400	4.00	233,600
Waterstops, Wrought Iron	L.F.	3,400	4.50	15,300
Intake Structure Superstructure	L.S.	1	-	100,000
5'8" x 10'0" Slide Gates & Liners	Each	4	150,000	600,000
Multiple Level Intake System	L.S.	1	-	80,000
Slide Gate Hydraulic System	L.S.	1	-	30,000
Low Flow Trash Racks, Bulkheads, and Guides	L.S.	1	-	12,000
Emergency Bulkhead Frames and Guides	L.S.	1	-	60,000
Pickup Beam	Each	1	-	7,000
Traveling Crane, 20 Ton	Each	1	-	45,000
Float Well Assembly	L.S.	1	-	10,500
Air Vent System	L.S.	1	-	15,000
Water Supply System	L.S.	1	-	17,200
Plumbing and Drainage	L.S.	1	-	5,700
Sump Pump	L.S.	1	-	1,700
Heating and Ventilating	L.S.	1	-	11,500
Electrical Work	L.S.	1	-	60,000
Standby Electric Generator	Each	1	-	15,000
Elevator and Shaft Framing	L.S.	1	-	40,000
Tile Gage	L.S.	1	-	3,000
Spiral Stairway	L.S.	1	-	4,600
Miscellaneous Ferrous Metals	L.S.	1	-	17,200
Miscellaneous Non-ferrous Metals	L.S.	1	-	11,500
Trash Guards	L.S.	1	-	23,000
Service Bridge	L.S.	1	-	25,000
Bulkhead Door	L.S.	1	-	1,200
Handrail	L.F.	240	7.50	1,800
Gaging Station	L.S.	1	-	50,000
Subtotal, Outlet Works				$3,528,800

TABLE 13-12 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
DAM AND APPURTENANCES (Cont'd)				
Access Road				
Road	Mile	3	$400,000	$1,200,000
Spillway Bridge	L.S.	1	-	400,000
Subtotal, Access Road				$1,600,000
Beautification				$ 260,000
Subtotal				$16,168,800
Contingencies				4,831,200
TOTAL, DAM & APPURTENANCES				$21,000,000
GENERAL RECREATION				
Facilities cost				$ 673,400
Contingencies				134,700
Subtotal, Facilities cost				$ 808,100
Specific general recreation lands				85,000
TOTAL, GENERAL RECREATION				$893,100
FISH AND WILDLIFE				
Facilities cost				$251,600
Contingencies				50,300
Subtotal, Facilities cost				$301,900
Specific fish and wildlife lands				0
TOTAL, FISH AND WILDLIFE				$ 301,900
TOTAL, GENERAL RECREATION AND FISH AND WILDLIFE				$1,195,000

TABLE 13-12 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
PERMANENT BUILDINGS AND OPERATING EQUIPMENT				
Operator's quarters	Ea.	2	$ 15,000	$ 30,000
Tractor, truck, boat, mower, tools, etc.	Lot	1	-	15,000
Utility building	Job	1	-	7,000
Rainfall and discharge stations				
Inflow Station	Job	1	-	20,000
Lake gage (on intake struct)	Job	1	-	4,000
Equipment for discharging station at dam	Job	1	-	2,000
Outflow station (downstream)	Job	1	-	20,000
Equipment for W.Q.C.	Job	1	-	10,000
Rainfall gages	Ea.	4	350	1,400
Radio facilities	Job	1	-	25,000
Beautification (oper. quarters)	Job	1	-	20,000
Subtotal				$ 154,400
Contingencies				30,000
TOTAL, PERMANENT BUILDINGS AND OPERATING EQUIPMENT				$ 185,000
ENGINEERING AND DESIGN	L.S.	-	-	$3,540,000
SUPERVISION AND ADMINISTRATION	L.S.	-	-	$2,968,000

TABLE 13-13

SUMMARY OF ANNUAL COST

LOWER KNOX DAM AND RESERVOIR PROJECT

Item	Financial	Economic
Interest on gross investment	$ 1,703,000	$ 1,729,000
Amortization of gross investment	72,300	72,300
Maintenance and operation	78,000	78,000
Major replacements	11,700	11,700
Total Annual Cost	$ 1,865,000	$ 1,891,000

TABLE 13-14

DETAILED ESTIMATE OF ANNUAL COST
LOWER KNOX DAM AND RESERVOIR PROJECT

Item	Financial Costs	Economic Costs
a. Total investment		
(1) Recapitulation of project costs		
(a) Initial costs	$ 49,200,000	$ 49,200,000
(b) Incremental costs	-	-
(c) Market value of lands	-	(1,480,000)
(2) Interest during construction (initial costs only) at 3-1/4% for 1/2 of construction period of 4 years	3,198,000	3,198,000
(3) Total gross investment	$ 52,398,000	$ 52,398,000
b. Annual initial costs		
(1) Interest on gross investment		
(a) Recreation	$ 48,000	$ 48,000
(b) Remaining costs (50,925,000) (0.0325)	1,655,000	1,655,000
(c) Adjustment for net loss of land (5%- 3-1/4%)(1,480,500)	-	26,000
(2) Amortization		
(a) Recreation	2,000	2,000
(b) Remaining costs (50,925,000) (0.00138)	70,300	70,300
(3) Maintenance and operation		
(a) Dam and reservoir	50,000	50,000
(b) Water quality control	5,000	5,000
(c) Recreation	23,000	23,000
(4) Major replacements		
(a) Dam and reservoir	2,000	2,000
(b) Water quality control	200	200
(c) Recreation	9,500	9,500
(5) Total annual initial costs	$ 1,865,000	$ 1,891,000
c. Annual future recreation incremental costs	0	0
d. Total annual costs	$ 1,865,000	$ 1,891,000

19. RESERVOIR RECREATION FACILITIES

Detailed recreation facilities costs for Lower Knox Reservoir are presented in table 13-15. The annual cost of operation and maintenance of the recreation facilities has been based on the reservoir management organization required for the estimated annual attendance, the various items of maintenance equipment required, and the roads to be maintained for recreation. The cost of replacement of the recreation facilities and roads was based on one-third of the facilities being replaced every 25 years over the 100-year economic life of the project. A detailed summary of the annual charges, including operation and maintenance, and the benefits for general recreation and fish and wildlife developments at Lower Knox Reservoir are presented in table 13-16.

20. DEVELOPMENT COSTS

Developmental benefits evaluated for the Lower Knox project stem from two sources - economic activity induced by the respending of wages earned by persons involved in project construction, operation and maintenance and wages resulting from expenditures made by recreation users within the region. It was assumed that existing facilities could supply 50 percent of the needs resulting from the injection of the redevelopment wages into the local economy. It was considered that as the needs increased, the additional facilities would be provided. Existing tourist and recreation facilities within the local area could accommodate very little of the needs resulting from the estimated recreation visitation. It was assumed, however, that within five years after initiation of project construction, the investment in recreation type facilities would be sufficient to accommodate the estimated visitation.

Based on the estimated construction and operation and maintenance wages and the visitation and expenditures by recreation users, the required facilities to supply food, lodging, transportation and other services were calculated. The cost of these facilities, to be provided by private investment, was estimated to be $710,000 for redevelopment and $162,000 for recreation. Assuming a 5% return on investment, average annual facility costs associated with redevelopment and recreation are estimated to be $35,800 and $8,200 respectively, a total of $44,000.

TABLE 13-15
DETAILED ESTIMATE OF GENERAL RECREATION
& FISH AND WILDLIFE RECREATION COSTS
LOWER KNOX DAM AND RESERVOIR PROJECT

SITE AND FACILITIES	ESTIMATED COST GENERAL RECREATION	FISH AND WILDLIFE	TOTAL
DAM OVERLOOK			
Parking (20 cars)	$ 6,000		$ 6,000
Shelter & Displays	10,000		10,000
Miscellaneous 1/	4,000		4,000
BELOW DAM FISHING ACCESS			
Access Road	50,000	50,000	100,000
Parking (25 cars)	4,000	4,000	8,000
Picnic Units (25)	7,000		7,000
Sanitary & Water Facilities	24,000	8,000	32,000
Miscellaneous 1/	9,000	9,000	18,000
DAM BOAT ACCESS			
Access Road	50,000	50,000	100,000
Boat Launching Ramp	4,000	3,000	7,000
Parking (50 cars & trailers 30 cars)	19,000	10,000	29,000
Picnic Units (30)	9,000		9,000
Sanitary & water facilitees	25,000	9,000	34,000
Miscellaneous 1/	12,000	11,000	23,000
KNOX VALLEY TRAILS			
Parking (50 cars)	15,000		15,000
Trails (including signs & shelters)	72,000		72,000
Sanitary & water facilities	17,000		17,000
Miscellaneous 1/	12,000		12,000
TURKEY CREEK BOAT ACCESS			
Access Road	10,000	10,000	20,000
Parking (50 cars & trailers, 20 cars)	19,000	7,000	26,000
Boat Launching Ramp	3,000	2,000	5,000
Picnic Units (30)	9,000		9,000
Picnic Shelters (1)	6,000		6,000
Sanitary & Water Facilities	30,000	10,000	40,000
Miscellaneous 1/	10,000	4,000	14,000

TABLE 13-15 (Cont'd)

SITE AND FACILITIES	ESTIMATED COST GENERAL RECREATION	FISH AND WILDLIFE	TOTAL
HURRICANE CREEK PICNIC AREA			
Access Road	$ 30,000		$ 30,000
Parking (50 cars)	15,000		15,000
Picnic Units (30)	9,000		9,000
Picnic Shelters (1)	6,000		6,000
Sanitary & Water Facilities	34,000		34,000
Miscellaneous 1/	12,000		12,000
CAMP CREEK TRAIL & PICNIC AREA			
Parking (70 cars)	30,000		30,000
Trails (including signs & shelters)	26,000		26,000
Picnic Units (40)	12,000		12,000
Picnic Shelters (2)	12,000		12,000
Sanitary & water facilities	37,000		37,000
Miscellaneous 1/	14,000		14,000
OLD ROUTE #697 FISHING ACCESS			
Parking (25 cars)		10,000	10,000
Road Improvement		50,000	50,000
Miscellaneous 1/		5,000	5,000
SUBTOTAL, FACILITIES COST	$673,000	$252,000	$925,000
Contingencies	135,000	50,000	185,000
	$808,000	$302,000	$1,110,000
ENGINEERING & Design and Supervision and Admin.	137,000	51,000	188,000
TOTAL FACILITIES COST	$945,000	$353,000 2/	$1,298,000

1/ Includes cost associated with landscaping; providing electrical power and other miscellaneous items.

2/ Cost for facilities that would be used both for fishing and hunting.

TABLE 13-16
SUMMARY OF CONSTRUCTION AND INVESTMENT COSTS
ANNUAL COSTS, ANNUAL BENEFITS AND VISITORS
GENERAL RECREATION AND FISH AND WILDLIFE DEVELOPMENT
LOWER KNOX DAM AND RESERVOIR PROJECT

ITEM	AMOUNT
Construction costs	
Facilities	$ 1,298,000
General Recreation Lands	85,000
Total construction costs	$ 1,383,000
Investment Costs	
Recreation Construction Cost	$ 1,383,000
Interest During Construction 1/	90,000
Total Investment	$ 1,473,000
Annual Recreation Costs	
Interest on Investment 2/	$ 48,000
Amortization of Investment 2/	2,000
Operation and Maintenance	23,000
Major Replacements 3/	9,500
Loss in Land Productivity 4/	1,500
Annual Economic Cost	$ 84,000
Annual Financial Cost	82,500
Visitation	
General Recreation	100,000
Fish and Wildlife	7,700
Total Visitation	107,700
Benefits	
General Recreation	$ 125,000
Fishing	3,900
Hunting	6,000
Total Benefits	$ 134,900

1/ 3-1/4% for 1/2 of construction period of 4 years
2/ Interest-project life 100 yrs. @ 3-1/4%, amortization = .00138 discount factor = .5401
3/ Major Replacement - Facility Investment x 1/3 x .7424 x .03388
4/ Loss in Land Production (5% - 3-1/4%)

SECTION V - BENEFITS

21. SUMMARY

Benefits from the Lower Knox Reservoir and associated developments would accrue to both the nation and project region. The benefits are grouped into two categories, user and expansion benefits. Tables 13-17 and 13-18 summarize these benefits by category, as well as crediting appropriate values to the National and/or regional account.

22. USER BENEFITS

User benefits directly resulting from the Lower Knox Reservoir development include flood control, low-flow augmentation and water-oriented recreation opportunities. The methods utilized in estimating the user benefits are discussed in the following paragraphs.

Flood control. Flood control benefits attributable to the Lower Knox Reservoir result from the reduction in flood stages and damages in downstream overflow areas along Tug Fork and the Big Sandy and Ohio Rivers. Evaluation of damages used to derive flood control benefits attributable to Lower Knox Reservoir were determined on the basis of reduction in damages with Lower Knox Reservoir acting alone and in a system with previously authorized Panther Creek Reservoir.

a. Flood damages. The overflow area which would be affected by operation of Panther and Lower Knox Creek reservoirs extended from Iaeger, W. Va., near Panther Creek, downstream to the confluence of Levisa and Tug Forks at Fort Gay, W. Va. For evaluating flood damages, this study area was divided into seven zones which included four rural reaches and three urban centers. Data used to develop flood damage estimates for the Big Sandy River are based on flood damage survey conducted by an independent engineering firm with previous experience in such surveys. The flood damages were up-dated to represent July 1968 prices and level of development. A summary of total flood damages by reach, in the Tug Fork basin for three recent floods is presented in Table 13-3 (page III-13-19).

b. Residential damages. In determining residential damages, depth of flooding and value of structure were obtained from field surveys. Utilizing these data, the damage for each residence, together with the furnishings, was determined from information based on other studies and prepared for this purpose. The tables estimated damage to the dwellings and furnishings based on the depth of water above the basement or first floor and the estimated value of the dwelling. The tables were checked for accuracy by interviews with approximately 10 percent of households affected.

TABLE 13-17

SUMMARY OF BENEFITS
TOTAL NATIONAL ACCOUNT
(July 1968 Prices & Level of Development)

Class of Benefit	System 1/ Panther Creek	System 1/ Lower Knox	System Total
User benefits			
Flood control	$ 182,800	$ 601,800	$ 784,600
Water quality	120,000	224,000	344,000
Recreation	279,100	134,900	414,000
Expansion benefits			
Redevelopment	76,600	148,400	225,000
Development	20,900	84,000	104,900
Total	$ 679,400	$ 1,193,100	$ 1,872,500

1/ Benefits distributed on a first place basis

TABLE 13-18

DETAILED SUMMARY OF BENEFITS
LOWER KNOX DAM & RESERVOIR
(July 1968 Prices & Level of Development)

Category and Class of Benefits	Annual Benefits: National Account Only	Annual Benefits: Regional Account Only	Annual Benefits: National and Regional Acct.	Total National Account	Total Regional Account
User Benefits					
Flood Control	$ 94,000	-	$ 507,800	$601,800	$507,800
Water Quality Control	-	-	224,000	224,000	224,000
Recreation	-	-	134,900	134,900	134,900
Total User Benefits	$ 94,000	-	$ 866,700	$960,700	$866,700
Expansion Benefits					
Redevelopment	-	$135,100	148,400	148,400	283,500
Development	-	253,000	84,000	84,000	337,000
Total Expansion Benefits	-	$388,100	$ 232,400	$ 232,400	$ 620,500
Total Benefits	$ 94,000	$388,100	$1,099,100	$1,193,100	$1,487,200

c. Commercial damages. Depth of flooding and valuation structures were obtained from field observation as indicated for residences. Personal interviews were conducted with owners or managers of approximately one-fourth of the commercial establishments and an estimate of flood damages obtained. Physical damage to the building structure and inventories were based on personal interviews and on field observation and comparison with other establishments.

d. Industrial damages. Damages to industrial plants were obtained by interviewing officials of each industry subject to flooding. Estimates of damage were made for various levels of flooding based on the information provided. Included was physical loss to buildings, equipment, materials and finished products, plus losses from decreased profit and continuing overhead expenses.

e. Municipal damages. Officials in all municipalities were interviewed and field investigations were made of all damageable city facilities including city streets. Flood damages were based on the value of the structures and their contents and the depth of flooding within the structures.

f. Utility damages. Utility damages were determined by the same procedure used for estimating industrial and municipal damages. This category includes damage to buildings and other major installations.

g. Schools, churches and fraternal organizations. Methods of obtaining damages for this category were much the same as those applied to residential and commercial property. Small churches and fraternal organizations were appraised in the same manner as residences. Damages to schools and large churches were obtained from personal interviews with pastors, principals or local boards of education.

h. Transportation damages. Flood damages to transportation routes were obtained by interviews with representatives of the Kentucky and West Virginia Highway Departments and officials of the Norfolk and Western Railroad. Damage estimates were supplemented by records of damage from previous floods and adjusted to current price levels.

i. Crop damage. Agricultural development in the Tug Fork Basin is limited due to the rugged terrain. Flood damages to agricultural crops in the study are small. Most of the lands that are cultivated are at a comparatively high level and are flooded only by large floods. Also, the lower cultivated lands are not planted until after the end of the winter and spring flood seasons. Some agricultural lands are damaged by deposition of undesirable silt during large floods. However, on an average annual basis, agricultural flood damages are so small that an estimate of those damages has not been made.

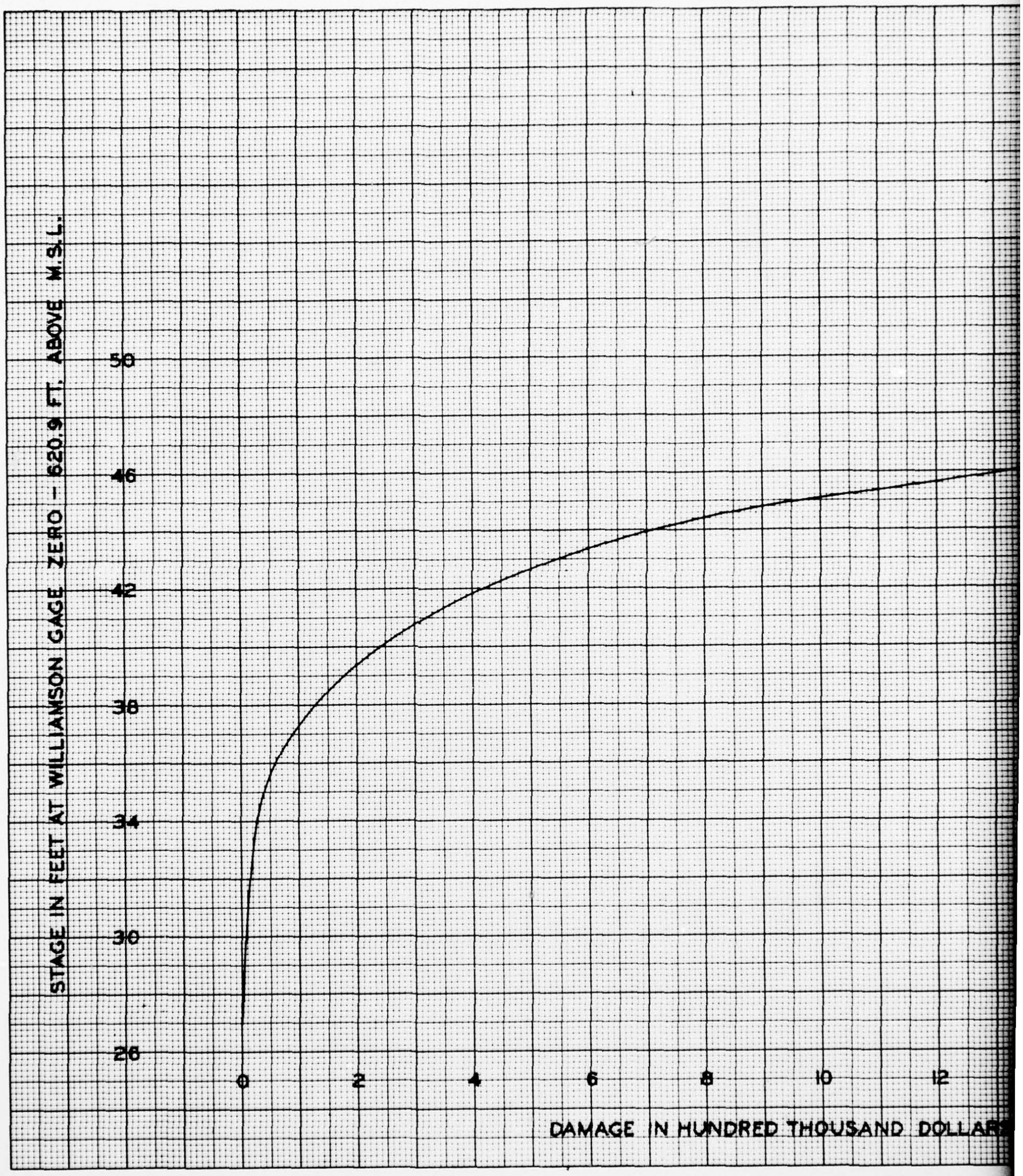
j. Damage curves. Damage curves for each reach and major damage center within the study area were obtained by combining all of the categories of damage into a composite curve. Sample stage-damage curves for Williamson are shown on exhibit No. 13-12. All damages prevented at Williamson, W. Va. inside the floodwall are credited to the Williamson Local Protection Project up to a point .5 foot below the top of the floodwall. The remaining damages prevented at Williamson accrue to the upstream reservoir projects. A summary of the average annual damages and damages prevented for Panther Creek and Lower Knox Reservoirs acting alone and in a system is presented in Table 13-19.

k. Future growth. Benefits will accrue to the flood control projects as a result of development that could be expected on the flood plain in the absence of these projects. These future damages prevented were computed by adjusting the average annual damages prevented to the existing development to reflect the anticipated future growth. Straight-line growth rates of 3.0 and 4.0 percent per year were used for different reaches of the Ohio River Valley and 2.0 percent per year for the Big Sandy River Valley and its tributaries were used to compute the benefits from the present time through the 100 year project life.

l. Average annual benefits. The difference between the average annual damages, with and without the flood protection project, represent the average annual damages prevented attributable to the project. Average annual flood control benefits for Panther Creek and Lower Knox were determined by adjusting the damages prevented to the existing development to reflect the future growth. The sum of the average annual benefits for Tug Fork, Big Sandy and Ohio Rivers provide the total flood control benefits for Panther and Lower Knox Reservoirs. A detailed breakdown of average annual flood control benefits for Panther Creek and Lower Knox Reservoirs acting alone and combined in a system are presented in Table 13-20.

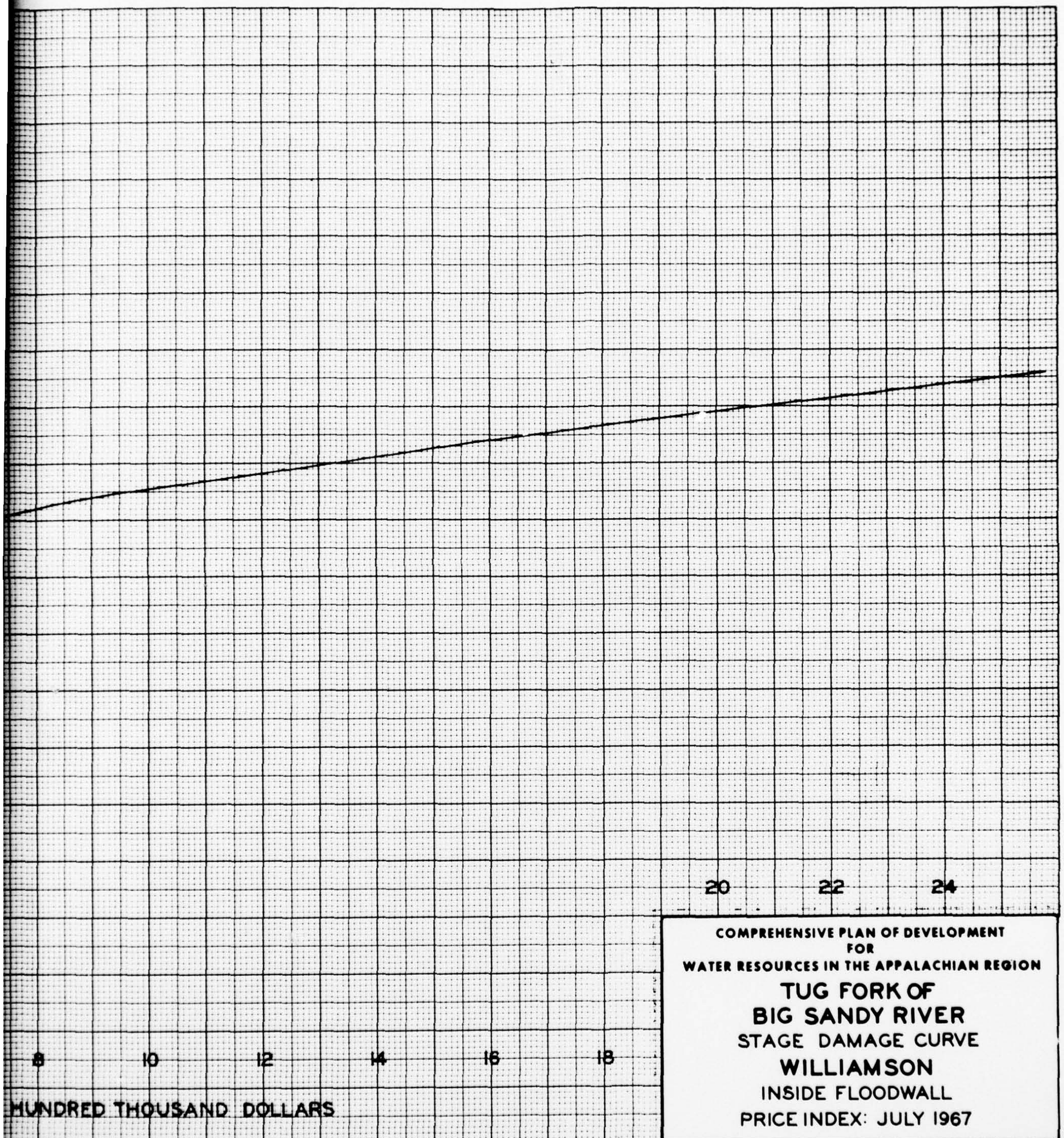
Enhancement. Uses of property in the study area would change little with the development of the flood control reservoirs. Therefore, benefits attributable to increased or higher utilization of property made possible by the proposed flood control reservoirs have not been evaluated.

General recreation. Recreation facilities for Lower Knox Reservoir are discussed in paragraph 16 of this chapter and the cost of these facilities is presented in paragraph 18 and summarized in Table 13-17. Benefits attributed to general recreation are based on an estimated annual visitation of 100,000, developed by the Corps of Engineers in cooperation with the Bureau of Outdoor Recreation. (See Appendix F). It was assumed by the cooperating agencies that the ultimate visitation would occur within the first three to five years of



STAGE IN FEET AT WILLIAMSON GAGE ZERO - 620.9 FT. ABOVE M.S.L.
50
46
42
38
34
30
26
0
2
4
6
8
10
12
DAMAGE IN HUNDRED THOUSAND DOLLARS

2



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

TUG FORK OF
BIG SANDY RIVER
STAGE DAMAGE CURVE
WILLIAMSON
INSIDE FLOODWALL
PRICE INDEX: JULY 1967

EXHIBIT 13-12 Sheet 1 of 2

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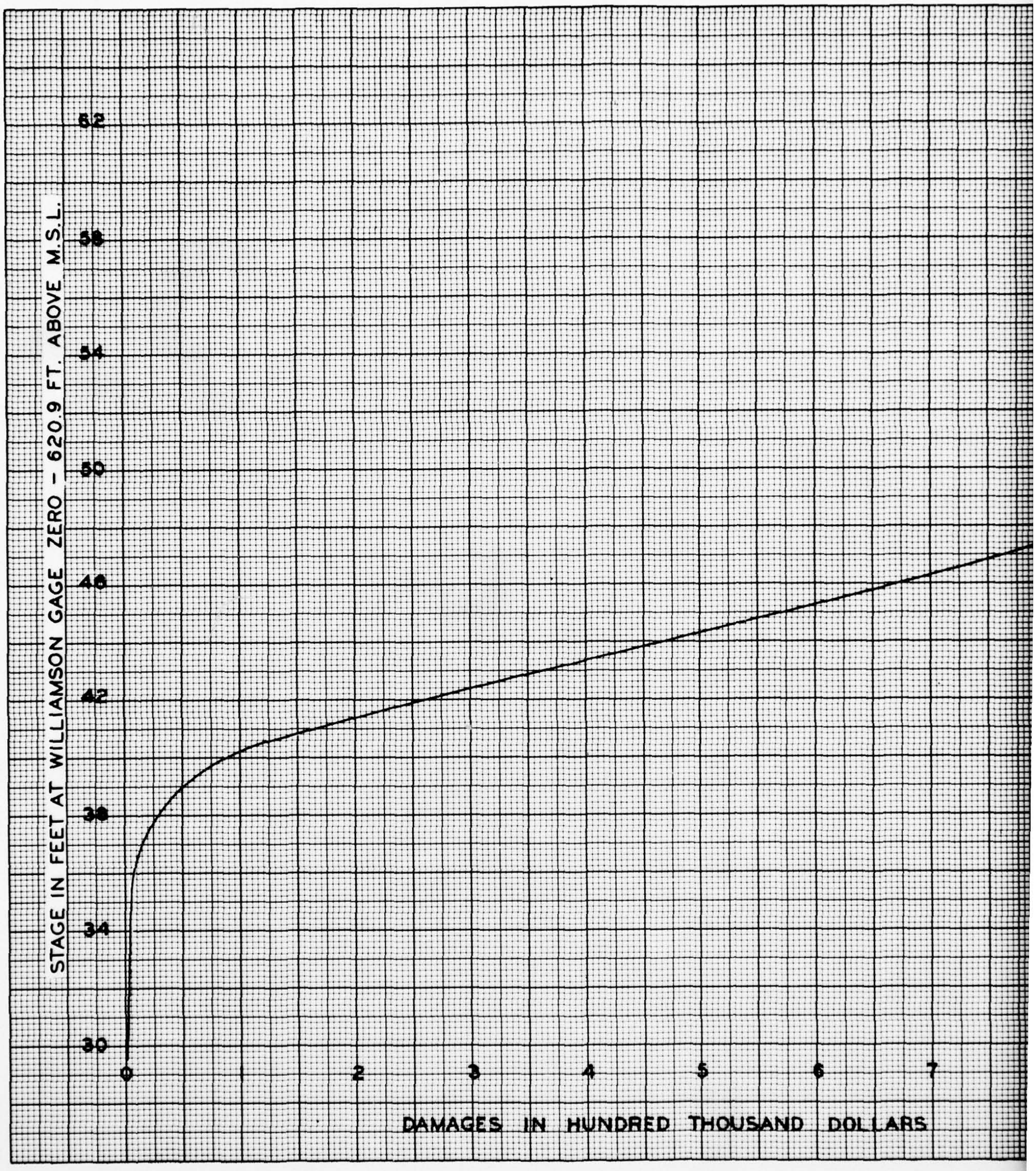

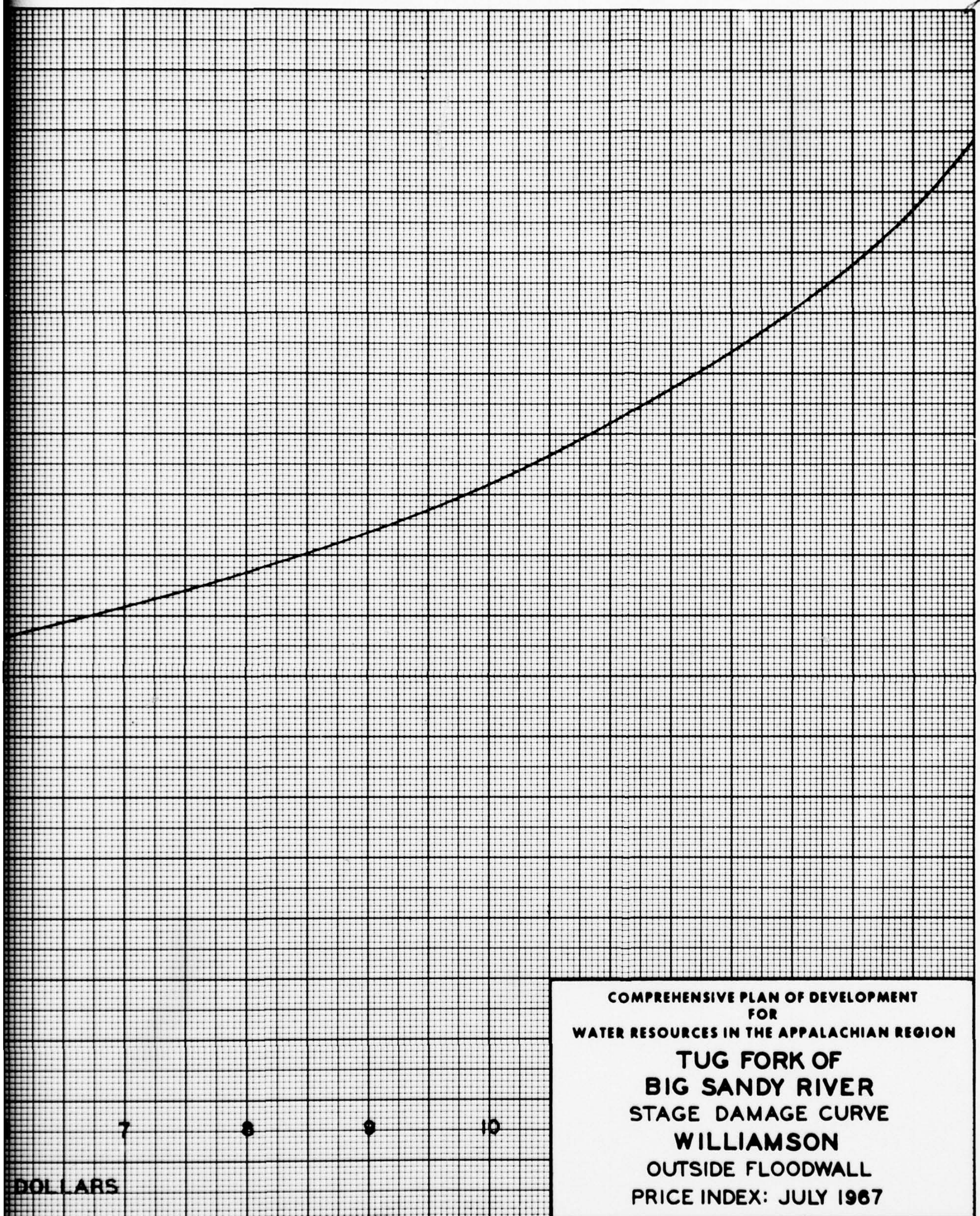

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

TUG FORK OF
BIG SANDY RIVER
STAGE DAMAGE CURVE
WILLIAMSON
OUTSIDE FLOODWALL
PRICE INDEX: JULY 1967

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TABLE 13-19

AVERAGE ANNUAL FLOOD DAMAGES
& FLOOD DAMAGES PREVENTED

(Based on July 1968 Prices & Level of Development)

Improvement Location Tug Fork Reach	Average Annual Damages	Average Annual Damages Prevented: First Place: Panther Creek	First Place: Lower Knox	System: Panther Creek	System: Lower Knox
Iaeger to Matewan	$ 28,300	$ 3,340	$ -	$ 3,340	$ -
Matewan	91,600	11,150	43,000	10,770	41,500
Matewan to Williamson	96,200	15,250	46,700	12,850	39,300
South Williamson	13,780	2,150	6,720	1,840	5,770
Williamson					
Inside Floodwall	130,700	20,150	64,200	16,940	53,900
Outside Floodwall	55,200	8,950	27,200	7,540	22,900
Williamson to Kermit	71,900	11,450	36,900	9,680	31,100
Kermit to Ft. Gay	6,920	830	2,510	720	2,190
Matewan to Ft. Gay					
Utilities	9,280	1,210	3,920	1,070	3,520
Highways	36,900	4,980	15,530	4,400	13,700
Railroads	57,200	7,750	25,400	6,820	22,400
Total, Tug Fork Reach	597,980	87,210	272,080	75,970	236,280
Big Sandy Below Louisa 1/	14,650	540	1,580	530	1,540
Total, Big Sandy	612,630	87,750	273,660	76,500	237,820
Ohio River		15,800	61,900	15,800	61,900
Grand Total		103,550	335,560	92,300	299,720
(Rounded)		$ 103,500	$335,600	$ 92,300	$299,700

1/ After existing & authorized reservoirs

TABLE 13-20

AVERAGE ANNUAL FLOOD CONTROL BENEFITS
(100 Yr. Project Life)

Improvement Location Tug Fork Reach	Average Annual Flood Control Benefits: First Place		System	
	Panther Creek	Lower Knox	Panther Cr.	Lower Knox
Iaeger to Matewan	$ 6,220	$ -	$ 6,220	$ -
Matewan	20,700	80,000	20,000	77,200
Matewan to Williamson	28,500	86,900	23,900	73,100
South Williamson	4,000	12,500	3,430	10,700
Williamson				
Inside Floodwall	37,500	119,300	31,500	100,100
Outside Floodwall	16,650	50,600	14,010	42,600
Williamson to Kermit	21,300	68,700	18,000	57,900
Kermit to Ft. Gay	1,640	4,670	1,340	4,070
Ft. Gay to Matewan				
Utilities	2,250	7,300	1,990	6,550
Highways	9,270	28,900	8,190	25,500
Railroads	14,410	47,800	12,690	41,700
Total, Tug Fork Reach	162,440	506,670	141,270	439,420
Big Sandy R. Below Levisa 1/	1,000	2,940	990	2,870
Total, Big Sandy River	163,440	509,610	142,260	442,290
Ohio River	40,550	159,500	40,550	159,500
Grand Total	$203,990	$669,110	$182,810	$601,790
(Rounded)	$204,000	$669,100	$182,800	$601,800

1/ After existing & authorized reservoirs

project operation with no future increment of visitation anticipated. Benefits were derived by assigning a monetary evaluation per recreation day to the estimated annual visitation. The evaluation is intended to measure the amount that users should be willing to pay, if such payment were required, to avail themselves of the project recreational activities and facilities. Using a benefit value of $1.25 per visitor-day, the total annual benefits for general recreation are estimated at $125,000.

Fish and wildlife. Estimated annual visitation and benefit values for fish and wildlife recreation were provided by the U. S. Fish and Wildlife Service. Annual fish and wildlife visitation is estimated to be 7,700 and benefit values per visitor-day are estimated as follows: $1.00 for reservoir fisher; $1.50 for tailwater fishery and $1.50 for project land hunting. Total annual fish and wildlife benefits are estimated at $9,900.

Water quality control. Studies made by the U.S. Public Health Service for House Document No. 246, 89th Congress, 1st Session, 20 July 1965, indicated that a proper method of determining water quality control benefits would be to estimate the most economical alternative method of providing the needed flow augmentation. The water quality control benefits as determined by the U.S. Public Health Service were based on cost for single purpose reservoirs at nine sites in the Tug Fork Basin recommended in an engineering report prepared by a consultant for the State of West Virginia. The average annual cost for providing developable sustained flows at the nine recommended sites was estimated to be $7,000 per c.f.s. of flow augmentation, based on 1960 construction costs.

Studies by the Huntington District in connection with water quality control storage in John W. Flannagan Reservoir concluded that the cost of providing water quality storage at the most economically favorable single purpose reservoir would be about $7,100 per c.f.s. of flow augmentation. Because of the increase in cost in certain phases of construction, the cost of providing a single purpose reservoir comparable to those in the U. S. Public Health Service study have increased. Based on July 1968 construction costs, it is estimated that the cost of providing water quality storage in the most economical single purpose reservoir would be about $8,000 per c.f.s. of flow augmentation, and this value has been used to estimate water quality benefits in this report.

The FWPCA has determined that a total flow of 70 c.f.s. would be required in Tug Fork by the year 2020 for the assimilation of organic and industrial waste. The 7-day once in 10-year low flow in Tug Fork is estimated to be 27 c.f.s. Previously authorized Panther Creek Reservoir will provide 15 c.f.s. Therefore, 28 c.f.s. has been allotted to Lower Knox Reservoir for low flow augmentation. The water quality control benefits for Lower Knox Reservoir are estimated to be $224,000.

User benefits of the Lower Knox Reservoir development are summarized in Table 13-21.

TABLE 13-21

SUMMARY OF USER BENEFITS
LOWER KNOX DAM & RESERVOIR
(July 1968 Prices & Level of Development)

Class of Benefits	Amount of Benefits 1/
Flood Control	
Tug Fork	$ 439,400
Big Sandy	2,900
Ohio River	159,500
Sub-total	$ 601,800
Water Quality Control	
Tug Fork and Big Sandy	224,000
Sub-total	$ 224,000
Recreation	
General	125,000
Fish and Wildlife	9,900
Sub-total	$ 134,900
Total User Benefits 2/	$ 960,700

1/ Lower Knox Reservoir acting in system with Panther Creek Reservoir
2/ Accruing to National Account

23. EXPANSION BENEFITS

Expansion benefits are divided into two categories, redevelopment and developmental. Redevelopment benefits consist of wage payments made to persons employed in the construction, operation and maintenance of the water resource project. Developmental benefits result from wage payments made to persons within the region not directly associated with the project, but whose employment results from the economic activity induced by the water project development.

Redevelopment benefits. Redevelopment benefits credited to the regional account consist of the average annual equivalent of all

labor wages earned in the construction, operation and maintenance of the water resource projects and spent within the region. Benefits credited to the National account are the wages earned by persons who would otherwise be unemployed or underemployed in the absence of the water project construction.

To determine redevelopment benefits it is necessary to estimate the portion of the total construction and operation and maintenance cost that would be wages. For this report, labor wages were estimated to be 25 percent of the construction cost less lands and damages, permanent equipment, engineering and design, and supervision and administration and 65 percent of the operation and maintenance expenditures. All of these wages are creditable to the regional account. It was estimated that 44 percent of the wages would be earned by persons previously unemployed or underemployed (unskilled and semi-skilled) and would therefore accrue to the National Account.

The following table summarizes the annual redevelopment benefits that are creditable to the regional and National account.

TABLE 13-22

SUMMARY OF REDEVELOPMENT BENEFITS
LOWER KNOX CREEK RESERVOIR

			Annual Redevelopment Benefits	
Item	Expenditure	Labor Cost (Wages) 1/	Total Nat'l. Acct. 2/	Total Reg. Acct. 2/
Construction	$38,186,000	$9,540,000	$ 142,000	$ 233,000
Annual Operation and Maintenance	77,800	50,500	6,400	50,500
Total Redevelopment Benefits			$ 148,400	$ 283,500

1/ Labor cost estimated to be 25% of construction cost less lands and damages, permanent equipment, engineering and design, and supervision and administration; 65% of operation and maintenance expenditures.

2/ Discounted over 100 year project life using 3-1/4 percent interest rate.

Developmental benefits. Developmental expansion benefits evaluated in this report include wages and salaries resulting from recreation user expenditures within the region, and the economic activity resulting from the recirculation of these wages and salaries as well as the

recirculation of wages and salaries associated with redevelopment. Benefits to the national account include wages and salaries of persons who in the absence of the water resource development and accompanying private development would be unemployed or underemployed. The regional account includes all wages and salaries accruing within the sub-region as a result of the water resource project and accompanying private development.

After extensive study by Huntington District and the Office of Appalachian Studies, because of the lack of developable land along Tug Fork that would be affected favorably by the flood control provided, no expansion effects were imputed to the flood control aspects of the project.

It is estimated that 107,700 visitors annually will be attracted to the recreation facilities at Lower Knox Reservoir. Expenditures made by recreationists and tourists are considered to vary according to the distance traveled to reach the project and will induce new commercial investment. The following tabulation summarizes the computations for determining the average annual visitor expenditures:

Annual Visitation	Distance of Travel (Mi.)	Percent of Total Visitation 1/	Daily Expenditures Per Visitor	Annual Expenditures
107,700	0-25	25	$ 0.50	$ 14,000
107,700	26-50	20	1.00	22,000
107,700	51-75	40	2.00	86,000
107,700	More than 76	15	4.00	65,000
		Annual Visitor Expenditures		$187,000

1/ Corps of Engineers Estimate.

For this study it was estimated that 30 percent of the visitor expenditures accrue as wages and salaries to individuals. It was assumed that all recreation service type employees (unskilled and semi-skilled) demanded by the recreation visitor expenditures would be previously unemployed or underemployed and therefore creditable to the National account. It was also assumed that over a period of 20 years the area would gradually approach full employment. Accordingly, developmental benefits accruing to the National Account are discounted to reflect this full employment condition in 20 years.

Appropriate county income multipliers, as contained in the study "Recreation as an Industry," prepared by Robert R. Nathan Associates, Inc., December 1966, were utilized and an average "multiplier" for the seven county area was obtained. This "multiplier" was applied to the wages and salaries resulting from visitor expenditures in order to determine the economic impact to the region.

It was considered that the multiplier effect would also apply to wages earned by persons employed in construction and operation and maintenance of the water project. The multiplier was therefore applied to determine the economic impact resulting from the recirculation of these wages. The estimated annual developmental benefits resulting from the recirculation of wages and salaries associated with recreation visitation expenditures and redevelopment are summarized in table 13-23.

TABLE 13-23

SUMMARY OF DEVELOPMENTAL BENEFITS
LOWER KNOX DAM & RESERVOIR

Item	Average Annual Benefits	
	Total National Account	Total Regional Account
Recreation Expansion	$ 11,000	$ 95,500
Redevelopment Expansion	73,000	241,500
Total Developmental Benefits	$ 84,000	$ 337,000

24. INTANGIBLE BENEFITS

In addition to the tangible benefits evaluated in the previous paragraphs, consideration must be given to those intangible benefits that although not being susceptible to monetary evaluation are, nevertheless, very real.

Health hazards resulting from flooding in the Tug Fork Basin are probably greater than in most other areas. Most of the areas outside municipalities rely on wells for water supply, and sanitary facilities are located outside the home. Coal mining wastes placed along stream banks are flushed into the stream by flood flows and together with silt and sand are deposited in buildings, streets and yards, making cleanup a slow process and, in most large floods, incapacitating the water supply of the municipalities.

Although the population of the basin has declined over the past twenty years, development on the flood plains has increased. The valley floors afford the only suitable terrain for development and continue to be developed despite publicity that has been directed to flood hazard.

Roads and railroads along the valley floors are inundated or damaged to such an extent in large floods as to paralyze business activities in areas not directly affected and may isolate communities or individual families for varying periods of time.

Many citizens of the Tug Fork area are convinced that flood control is pre-requisite to other forms of area development and community upgrading. Emphasis has been placed generally on construction of flood control structures to prevent inundation of existing and potential development. Less emphasis has been placed on zoning, floodproofing, temporary evacuation of damageable material and other management programs for minimizing damages from the flooding which must be expected as a natural event. Lack of a vigorous program for flood plain management stems from scarcity of developable, flood-free land and a local feeling that flood damage is unavoidable without the Lower Knox project. The unpredictable and erratic pattern of stream rises causes implementation of emergency protection and emergency evacuation plans to be extremely difficult and have caused many residents to consider preparation of such emergency plans as being mere exercises in futility. Lack of emphasis on plans for emergency protection and emergency evacuation; necessity of making similar repair and/or replacement to building interiors, furnishings, and equipment following each inundation; and the repetitive nature of damaging floods are factors that cause many property owners to expend minimum effort in repairing or rehabilitating facilities following flood periods. Many individual properties and some entire communities therefore acquire a run-down, deteriorated appearance which is a negative factor in encouraging economic development or expansion from investors residing outside of the area.

Local interests, through their Congressional delegations and through State and local governmental representatives and organizations, persistently have sought for water resources development. In the words of the Tug Valley Chamber of Commerce, "The greatest individual need within the entire Tug Fork Valley is the need for adequate flood control. The constant threat of flooding each year has done more to hinder economic growth than any one thing. Tug Fork must have flood control to grow; or even to continue to exist." Provision of any degree of flood protection (by projects such as Lower Knox Reservoir) would produce a significant, although intangible, change in the attitude of the populace with a resulting change in economic activity. The state of chronic anxiety and the depressive attitudes that permeate the area would be relieved by reduction of the flood hazard. Experience at Williamson, West Virginia, and other locations, indicates that completion of a flood control project (providing either a high or limited degree of protection) causes a noticeable change in the rate and type of development within the protected area.

Therefore, development of the Lower Knox Creek Reservoir (or similar projects), by relieving the feeling of futility at the local level, may be the catalyst needed to stimulate change to other lagging parameters of economic activity and self-improvement.

SECTION VI - ECONOMIC ANALYSIS

25. ECONOMIC DATA

Project costs. Annual financial and economic costs for Lower Knox Reservoir were computed utilizing data developed in Section IV of this chapter. These costs differ slightly in that economic costs allow for loss of land productivity which is based on 5 percent annual net income on lands taken for the reservoir project. The economic costs and the associated private developmental costs for Lower Knox Reservoir are presented in table 13-24.

TABLE 13-24

PROJECT AND DEVELOPMENT COST
LOWER KNOX DAM AND RESERVOIR PROJECT
(July 1968 Prices)

Item	Amount
Construction Cost	$ 49,200,000
Annual Cost	
Interest @ 3-1/4%	1,703,000
Amortization in 100 years	72,300
Maintenance and operation	78,000
Major replacements	11,700
Total annual financial cost	$ 1,865,000
Land productivity loss	26,000
Total annual economic cost	$ 1,891,000
Associated developmental cost	44,000
Total Annual Project & Development Cost	$ 1,935,000

Project benefits. The annual economic benefits were developed and discussed in Section V of this chapter. A summary of total annual benefits for Lower Knox Reservoir is presented in Table 13-25.

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TABLE 13-25

SUMMARY OF ANNUAL BENEFITS
LOWER KNOX DAM & RESERVOIR DEVELOPMENT[1/]

Type of Benefit	Annual Benefit: Total National Account	Annual Benefit: Total Regional Account
User	$ 960,700	$ 866,700
Redevelopment	148,400	283,500
User plus redevelopment	$ 1,109,100	$ 1,150,200
Development	84,000	337,000
Total annual benefits	$ 1,193,100	$ 1,487,200
Expansion (Redevelopment plus Development)	232,400	620,500

1/ For more detailed breakdown and discussion of annual benefits see Section V

26. INDICES OF PERFORMANCE

Several indices of performance can be computed to evaluate the economic feasibility of a water resource project. One index of performance can be presented, being the conventional ratio of benefits to cost generally developed for water resources projects. The numerator contains annual user benefits plus those employment benefits attributable to direct construction and operation of the water projects (redevelopment benefits). The denominator is the annual economic cost of the water project. This ratio expresses the minimum index of performance in regard to national income augmentation.

A second index of performance evaluates the contribution that Lower Knox Reservoir development would make to employment expansion within the region. The numerator consists of increased annual wage payments for construction and operation and maintenance of the water project, wage and salaries resulting from the annual recreation expenditures, plus wages and salaries generated by the associated private investment, all which accrue to the region. The denominator is the total annual project cost, including private developmental costs, which are necessary to effect the increase in employment within the region. The indices of performance herein discussed are shown in Table 13-26.

TABLE 13-26

PERFORMANCE SUMMARY
LOWER KNOX DAM & RESERVOIR

	Benefit/Cost	Index of Performance
Conventional	1,109,100 / 1,891,000	0.59
Regional employment	620,500 / 1,935,000	0.32

27. ALLOCATION OF COSTS

Costs of the Lower Knox Reservoir project were allocated by the separable cost-remaining benefit method, the separable cost of each user purpose being allocated to that purpose and the joint costs allocated to user purposes plus regional income expansion. A description of the projects used to estimate separable cost and alternate cost is given in table 13-27. An alternative annual cost derivative for general and fish and wildlife recreation is presented in table 13-28. A summary of costs for these projects is given in table 13-29. A cost allocation by the separable costs-remaining benefits method for Lower Knox Reservoir is presented in table 13-30.

TABLE 13-27

DESCRIPTION OF PROJECTS USED FOR ESTIMATING
SEPARABLE AND ALTERNATE COSTS
LOWER KNOX DAM & RESERVOIR

BASIS FOR SEPARABLE COSTS	BASIS FOR ALTERNATE COSTS
FLOOD CONTROL	
Reservoir at Lower Knox site with water quality control pool at elevation 826 and top of dam at elevation 861.	Single-purpose reservoir at the Lower Knox site with flood control pool 918 providing 8.0" of flood storage.
WATER QUALITY CONTROL	
Reservoir at Lower Knox site with recreation pool at elevation 826 and flood control pool at elevation 925, providing 7.9" of flood storage. Full recreation development.	Costs developed in studies by the Public Health Service for nine single purpose reservoir sites in W. Va. and subsequently used for 22 reservoir sites in the upper Tug Fork basin.

TABLE 13-27 (Cont'd)

BASIS FOR SEPARABLE COSTS	BASIS FOR ALTERNATE COSTS
RECREATION	
Reservoir at Lower Knox site with water quality control pool at elevation 826 and flood control pool at elevation 925 providing 7.9" of flood storage. No recreational lands or facilities.	State park type recreational development.
REGIONAL EXPANSION	
The multiple-purpose reservoir project at the Lower Knox site without the developmental plan.	Single-purpose state park type development and the developmental plan plus making the redevelopment benefits of the alternate equal that of the reservoir project plan.

TABLE 13-28

ALTERNATIVE ANNUAL COST DERIVATION FOR
GENERAL AND FISH AND WILDLIFE RECREATION

General recreation and fish and wildlife recreation

Land acquired specifically for general recreation		950
Joint use lands available to general recreation		3,800
	Total	4,750 Acres

Annual attendance

General recreation		100,000
Fish and wildlife		7,700
	Total	107,700

$$\frac{107{,}700 \text{ (Annual attendance)}}{4{,}750 \text{ acres}} = 22.7 \text{ visitors/acre, density}$$

Annual cost per visitor day =	$ 1.09
Annual cost per visitor day escalated to July 1968 prices =	1.53
Total alternative annual economic cost 107,700 x $1.53	$164,600

TABLE 13-29
LOWER KNOX DAM AND RESERVOIR
SUMMARY OF CONSTRUCTION EXPENDITURES, ANNUAL OPERATION AND
MAINTENANCE COSTS, AND INVESTMENT AND ANNUAL CHARGES
FOR THE SELECTED PLAN OF DEVELOPMENT
(In thousands of dollars)

	Multiple Purpose Reservoir					Alternate Single Purpose Projects				Multiple Purpose Project Less			
	Specific Use Lands & Facilities												
Item	Regional Economic Expansion	Water Quality	Recreation	Joint Use Costs	Total Costs	Flood Control	Regional Economic Expansion	Water Quality	Recreation	Flood Control	Water Quality	Recreation	Regional Economic Expansion
Construction First Cost													
Lands and damages		-	85.0	4,347.0	4,432.0	4,347.0				1,579.0	4,432.0	4,347.0	4,432.0
Relocations		-	-	18,490.0	18,490.0	18,339.0				11,474.0	18,490.0	18,490.0	18,490.0
Reservoir & pool preparation		-	-	193.0	193.0	145.0				149.0	193.0	193.0	193.0
Dam & appurtenances		156.0	-	24,414.0	24,570.0	24,272.0				21,337.0	24,414.0	24,570.0	24,570.0
Recreation facilities		-	1,299.0	-	1,299.0	-				1,299.0	1,299.0	-	1,299.0
Permanent operating equipment		14.0	-	202.0	216.0	203.0				183.0	202.0	216.0	216.0
Construction costs (water project)		170.0	1,384.0	47,646.0	49,200.0	47,306.0				36,021.0	49,030.0	47,816.0	49,200.0
Development plan	872.0	-	-	-	872.0	-				872.0	872.0	872.0	-
Total construction costs	872.0	170.0	1,384.0	47,646.0	50,072.0	47,306.0				36,893.0	49,902.0	48,688.0	49,200.0
Investment Costs													
Initial Construction Costs		170.0	1,384.0	47,646.0	49,200.0	47,306.0				36,021.0	49,030.0	47,816.0	49,200.0
Interest during construction		12.0	90.0	3,096.0	3,198.0	3,075.0				2,341.0	3,186.0	3,108.0	3,198.0
Investment cost, initial increment		182.0	1,474.0	50,742.0	52,398.0	50,381.0				38,362.0	52,216.0	50,924.0	52,398.0
Future recreation facilities		NO FUTURE FACILITIES			-	-					NO FUTURE FACILITIES		-
Development plan	872.0	-	-	-	872.0	-				872.0	872.0	872.0	-
Total investment costs	872.0	182.0	1,474.0	50,742.0	53,270.0	50,381.0				39,234.0	53,088.0	51,796.0	52,398.0
Annual Financial Charges													
Initial Increment													
Interest & amortization	44.0	6.8	51.1	1,717.4	1,819.3	1,706.9				1,343.7	1,812.5	1,768.2	1,775.3
Operation & maintenance													
Recreation		-	23.0	-	23.0	-				23.0	23.0	-	23.0
Dam		5.0	-	50.0	55.0	50.0				45.0	50.0	55.0	55.0
Major Replacement													
Recreation		-	9.5	-	9.5	-				9.5	9.5	-	9.5
Dam		0.2	-	2.0	2.2	2.0				1.5	2.0	2.2	2.2
Total Annual Financial Charges	44.0	12.0	83.6	1,769.4	1,909.0 1/	1,758.9	477.6	224.0 2/	164.6 3/	1,422.7	1,897.0	1,825.4	1,865.0

1/ Does not include economic charge for net loss of land productivity of $26,000. Total economic cost for project would be $1,935,000 annually.

2/ Based on least expensive alternative as computed by U.S. Public Health Service.

3/ State park type development.

TABLE 13-30
LOWER KNOX DAM AND RESERVOIR
ALLOCATION OF COSTS
FOR THE SELECTED PLAN OF DEVELOPMENT
(In thousands of dollars)

Item	User Effects: Flood Control	User Effects: Water Quality	User Effects: Recreation	Regional Expansion Effects	Total
1. Benefits	601.8	224.0	134.9	620.5	1,581.2
2. Alternative costs	1,758.9	224.0	164.6	477.6	2,625.1
3. Benefit limits	601.8	224.0	134.9	477.6	1,438.3
4. Separable costs	486.3	12.0	83.6	44.0	625.9
5. Remaining benefits	115.5	212.0	51.3	433.0	812.4
6. Allocation of restricted joint costs 1/					
a. Remaining benefits	0	212.0	51.3	0	263.3
b. Ratio	-	0.806	0.194	-	1.000
c. Allocated restricted costs	0	8.5	2.1	0	10.6 1/
7. Separable plus allocated restricted costs	486.3	20.5	85.7	44.0	636.5
8. Remaining benefits	115.5	203.5	49.2	433.0	801.2
9. Ratio	0.144	0.254	0.061	0.541	1.000
10. Allocated joint costs 2/	183.2	323.3	77.6	688.4	1,272.5
11. Total allocated financial costs	669.5	343.8	163.3	732.4	1,909.0
ALLOCATION OF OPERATION, MAINTENANCE AND REPLACEMENT COSTS 3/					
12. Separable OM&R Charges	10.7	5.2	32.5	0	48.4
13. Allocated joint OM&R 2/	6.0	10.5	2.5	22.3	41.3
14. Total allocated OM&R	16.7	15.7	35.0	22.3	89.7
ALLOCATION OF INVESTMENT COSTS					
15. Annual investment costs	652.8	328.1	128.3	710.1	1,819.3
16. Capitalized Investment costs	19,264.0	9,682.0	3,786.0	20,538.0	53,270.0
17. Adjustment for discount on future increment		NO FUTURE FACILITIES		-	-
18. Total allocated investment costs	19,264.0	9,682.0	3,786.0	20,538.0	53,270.0
ALLOCATION OF CONSTRUCTION COSTS					
19. Investment in specific use lands & facilities	-	182.0	1,474.0	872.0	2,528.0
20. Investment in joint use lands & facilities	19,264.0	9,500.0	2,312.0	19,666.0	50,742.0
21. Interest on joint use lands and facilities	1,176.0	579.0	140.0	1,201.0	3,096.0
22. Allocated construction costs of joint use lands & facilities	18,088.0	8,921.0	2,172.0	18,465.0	47,646.0
23. Construction costs of specific use lands & facilities	-	170.0	1,384.0	872.0	2,426.0
24. Total allocated construction costs	18,088.0	9,091.0	3,556.0	19,337.0	50,072.0
25. Construction costs of future increment		NO FUTURE FACILITIES		-	-
26. Construction costs of Development Plan	-	-	-	872.0	872.0
27. Construction costs of water project (Initial)	18,088.0	9,091.0	3,556.0	18,465.0	49,200.0
28. Total construction costs of water project	18,088.0	9,091.0	3,556.0	18,465.0	49,200.0

1/ Steps in determination of allocated restricted joint costs for recreation and water quality control.
(a) Derive separable costs in line 4 for all purposes in accordance with regular procedure - the difference between the cost of the multiple purpose project and the cost of the multiple purpose project with one purpose omitted.
(b) Subtract from the multiple purpose project the cost of the single purpose flood control project at the site.
(c) Subtract from remainder of (b) above the sum of separable costs allocated to recreation and water quality control.
The remainder of this computation is the sum of the restricted joint costs ($10.6) that serve recreation and water quality control.
(d) The sum of the restricted joint costs are allocated in proportion to remaining benefits for the three purposes.

2/ In proportion to remaining benefits (line 8).

3/ There are no restricted joint O. M. & R. costs to be allocated.

4/ Flood control, water quality control and recreation costs are capitalized to present worth by (29.5129) X annual investment costs. Remainder of capital costs are allocated to Regional Economic Expansion effects.

SECTION VII - COST SHARING

28. GOVERNING LEGISLATION

Apportionment of costs for the multiple purpose Lower Knox Creek Reservoir between Federal and non-Federal interests is made according to the following criteria and summarized in Table 13-31.

a. All costs allocated to flood control are apportioned to the Federal Government in accordance with Section 201 of the Flood Control Act of 1958 (PL 85-500). The effects of the project are widespread in the sense of economic impact over the study area and along the Big Sandy and Ohio Rivers.

b. All costs allocated to water quality control are apportioned to the Federal Government according to the Water Pollution Control Act of 1961 (PL 87-88). Widespread benefits accrue to the project because of the economic impact of the project services along Tug Fork as well as the Big Sandy River.

c. All costs allocated to recreation are apportioned to the Federal Government and non-Federal interests according to the Federal Water Project Recreation Act of 1965 (PL 89-72). This act states, in part, that non-Federal interests must bear not less than one-half the separable costs of the project allocated to either or both recreation and fish and wildlife enhancement and all of the costs of operation, maintenance and replacement.

29. APPORTIONED COSTS

A summary of apportioned costs between Federal and non-Federal interests is presented in the following table.

TABLE 13-31

APPORTIONMENT OF COSTS BETWEEN FEDERAL AND NON-FEDERAL INTERESTS (Thousands)

Construction costs	
Federal	$ 48,508.0
Non-Federal	692.0
Total	$ 49,200.0
Annual O&M and replacement charges	
Federal	57.2
Non-Federal	32.5
Total	89.7

30. STATE AND LOCAL ASSURANCES

Prior to construction, non-Federal interests must agree to bear not less than one-half the separable recreation costs and all the operation, maintenance and replacement costs. Inquiries have been made of the Commonwealth of Kentucky, in which the project lies, the State of West Virginia, where flood control benefits would be greatest, and the Commonwealth of Virginia, where severance lands would be used for wildlife management and public hunting. In a letter dated August 26, 1969, Mr. Jewell Graham, Director, Division of Water, Kentucky Department of Natural Resources, expresses interest in the studies of the Tug Fork Basin and notes that there has been considerable favorable local interest in the project. He further states that should the project be implemented the report provides a firm basis for the consideration of interstate arrangements and state participation in the recreational developments associated with the project. This letter is included as exhibit 13-13.

In a letter dated August 15, 1969, Mr. T. R. Samsell, Director, West Virginia Department of Natural Resources, expresses general approval of the project. He states that West Virginia would consider a study as to possible interstate agreement for the project and a practical course of action for the provisions of recreation assurance. This letter appears as exhibit 13-14.

Mr. J. M. Alexander, Commissioner, Division of Water Resources, Department of Conservation and Economic Development, Commonwealth of Virginia, in a letter dated August 27, 1969, states that the Virginia Commission of Game and Inland Fisheries would accept the lands taken for the project for wildlife management and public hunting. This letter is included in exhibit 13-15.

In addition to the cost sharing that is required, all States must exercise, to the full extent of their capability, control against removal of stream flow made available for water quality control.

LOUIE B. NUNN
GOVERNOR

JAMES S. SHROPSHIR
COMMISSIONER

JEWELL GRAHAM
DIRECTOR

TELEPHONE 564-3980

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER
FRANKFORT, KENTUCKY 40601

August 26, 1969

Colonel John C.H. Lee, Jr.
Corps of Engineers
Office of Appalachian Studies
P. O. Box 1159
Cincinnati, Ohio 45201

Dear Colonel Lee:

This is to express the interest of the Commonwealth of Kentucky in the studies of the Lower Knox Creek Reservoir Project (Tug Fork Basin) as presented in Chapter 13-Part III of the Main Report on Development of Water Resources in Appalachia.

The detailed analysis of water resource development potential in Tug Fork Basin you have made will be of great value in our continuing considerations of water problems in the basin. There has been considerable local interest favorable to a reservoir in the area and we feel your studies demonstrate that every effort to find a meritorious project has been made.

While determined infeasible at this time, your studies of the Lower Knox Creek Reservoir can be used in the light of changed future conditions and needs as a basis for reinvestigation at a proper time.

The needs for interstate arrangements and state participation in recreational developments associated with the project are well defined in the report. This information provides a firm basis for consideration by the states should implementation of the project be undertaken.

Sincerely yours,

Jewell Graham

Jewell Graham, Director
Division of Water

JG:SMT:sa

Exhibit 13-13

"EVERY KENTUCKIAN COUNTS"

STATE OF WEST VIRGINIA

DEPARTMENT OF NATURAL RESOURCES

CHARLESTON 25305

T. R. SAMSELL
DIRECTOR

August 15, 1969

Colonel John C. H. Lee, Jr.
Corps of Engineers
Office of Appalachian Studies
P. O. Box 1159
Cincinnati, Ohio 45201

Dear Colonel Lee: Re: ORADA

In reply to your comments during the July 22, 1969 meeting and the additional information contained in your letter of July 23, 1969 it is believed that certain statements are in order concerning West Virginia's policy on the proposed Tug River Basin projects.

At this time, West Virginia can express its general approval of the proposed Lower Knox Creek project. Further, West Virginia would be willing to consider a study relative to a possible interstate agreement concerning this project. Finally, it is the State of West Virginia's intent that consideration may be given to a practical course of action for the provision of recreation assurance for the proposed project.

Sincerely,

T. R. Samsell
Director

TRS/mms

COMMONWEALTH OF VIRGINIA

DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT

DIVISION OF WATER RESOURCES
SEVENTH FLOOR, 911 EAST BROAD STREET
RICHMOND, VIRGINIA 23219
J. M. ALEXANDER, P.E., COMMISSIONER

August 27, 1969

Colonel John C. Lee, Jr., Director
Office of Appalachia Studies
Corps of Engineers, Department of the Army
Post Office Box 1159
Cincinnati, Ohio 45201

Dear Colonel Lee:

This is in reference to your memorandum of August 11, 1969 relative to the Lower Knox Creek Reservoir which would extend into Buchanan County, Virginia, and in which certain lands would be taken which could be managed for wildlife.

We have been informed by the Executive Director of the Virginia Commission of Game and Inland Fisheries that the Commission would consider favorably the acceptance of those severance lands in Virginia for the purpose of wildlife management and public hunting.

Sincerely yours,

J. M. Alexander

J. M. Alexander, P.E.
Commissioner

JMA/bb

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SECTION VIII - COORDINATION IN PLANNING

31. FEDERAL AGENCIES

During planning, studies were coordinated with the United States Departments of Agriculture, Commerce, Interior, and Health, Education and Welfare, the Federal Power Commission and the Appalachian Regional Commission.

Many Federal agencies such as the U. S. Geologic Survey, Environmental Science Service Administration, and the Office of Business Economics provided basic data for project planning, such as climatologic, streamflow, and economic records through regular publications or special reports. Other Federal agencies participated indirectly by assisting the state and local agencies and planning groups.

Bureau of Outdoor Recreation. BOR surveyed the recreation market area and determined that the demand for recreation opportunities, present and future, exceeds the capabilities of the recreation developments of the project area.

Federal Water Pollution Control Administration. The FWPCA investigated the conditions in the Tug Fork Basin and concluded that no water supply storage was needed but that the present and future waste load was greater than the assimilative capacity of the stream-flow at certain locations. Subsequently, storage was allocated to supply water needed for water quality control, considering the optimum balance of benefits for this purpose and for recreation.

Fish and Wildlife Service. The Bureau of Sport Fisheries and Wildlife studied the Lower Knox Creek area to evaluate the mandays of fishing and hunting afforded by the stream and its contiguous areas. The Bureau recommended stocking the reservoir, development of adjacent recreation areas to facilitate fisherman access and permitting hunting on project lands consistent with wildlife population and safety of other recreationists. The Corps of Engineers concurred in the recommendations and included suitable facilities in the plan of initial development of the recreation areas. Local interests, preferably the States of Kentucky and Virginia, as the administrative agency or agencies, for the land and water recreation areas would be responsible for regulations to permit hunting in the project areas.

National Park Service. The objectives of the National Park Service are:

(a) Preservation and enhancement of areas of unique scenic, archeological, historic, and natural science values.

(b) Improvement of land and water quality management.

(c) Consideration of structural and non-structural measures, beneficial flow regulation, and flow regulation storage.

In addition to the above; Public Law 89-665, the National Historic Preservation Act of 1966 requires that any Federal or Federally assisted undertaking in any state take into account its effect on any historic site or structure listed in the National Register of Historic Places. The National Register of Historic Places is a list of properties significant to the nation, to the states, and to local areas because of significance in history, architecture, archaeology, and culture.

Studies by the National Park Service to carry out these objectives will be requested by, and coordinated with the appropriate office having responsibility for construction of this project. These studies will be requested when advanced engineering and design for the project is initiated.

32. PUBLIC HEARING

22 November and 14 December 1963. A public hearing was scheduled by the District Engineer, U. S. Army Engineer District, Huntington, for 1:00 P.M., E.S.T., 22 November 1963, at Pikeville, Kentucky, to present to the public the general plans of projects being considered and to obtain their views regarding the plans and to discuss water resources development in the Big Sandy River Basin. The scheduled hearing was interrupted by and discontinued due to receipt of news of the death of the President of the United States. The hearing was rescheduled and continued at the same location on 14 December 1963.

In attendance on both dates were the Congressman from the Seventh U.S. Congressional District of Kentucky, various Federal, state, county and city officials, land owners, coal operators and owners, railway officials, and other interested parties. Copies of the transcript of the hearing are available in the Office of the District Engineer, U.S. Army Engineer District, Huntington, West Virginia.

The Tug Valley Chamber of Commerce expressed intense interest in obtaining the maximum amount of flood protection that could be justified for the Tug Valley and requested that full consideration be given to the possibility of developing a reservoir near the mouth of Knox Creek, which is a tributary of Tug Fork, upstream from the areas of major damage.

The railroad and mineral interests were concerned with railroad relocations required for the Lower Knox Creek Reservoir and the extensive effect on mining.

Additional views expressed concerning water resource development. Following the hearings, meetings were held with groups of coal owners

and operators, representatives of the N&W Railway Company, and groups representing the Tug Valley Chamber of Commerce and the citizens of Buchanan County, Virginia. The coal interests presented evidence to substantiate their claims of coals that would be rendered unrecoverable or for which operating expenses would increase due to the reservoir project. The N&W Railway officials discussed the railroad relocations that would be required and presented criteria that they feel should be used in design of such relocations to minimize adverse effects on their operations. The group from the Tug Valley Chamber of Commerce reiterated their desire for maximum flood control on Tug Fork with particular emphasis on the project at the mouth of Knox Creek.

Local interests, through their Congressional delegations and through State and local governmental representatives and organizations, persistently have sought for water resources development especially for flood control. Although it is recognized that water resources development must meet requirements for economic feasibility, most of the citizens, officials, and business interests in the area feel that special measures should be taken to protect their property and well-being.

Local delegations have reiterated at every opportunity that special criteria should be evolved to permit economic justification for water resources development in consonance with the purposes of the Appalachian Regional Development Act of 1965 to combat poverty and to promote well-being and prosperity in areas wherein there is a lag in economic growth. They also express a strong opinion that the recreational cost-sharing policy is not equitable since elimination or reduction in scope of reservoir projects because of local inability to participate may give unfair advantage to wealthier areas and may preclude sorely needed public improvements that could be a stimulus to the economy of the distressed areas.

A report prepared in 1966 by the Tug Valley Chamber of Commerce states that "as to human misery, loss of life, loss of desire to establish and expand business firms, we have no means by which to measure or with which to project these losses." The report concludes that "The greatest individual need within the entire Tug Fork Valley is the need for adequate flood control. The constant threat of flooding each year has done more to hinder economic growth than any one thing."

Little concern has been evidenced by local interests toward purposes or needs for water resources development other than the flood control aspect. Water-oriented recreation, fish and wildlife enhancement, and low-flow regulation are recognized as desirable functions but are regarded as ancillary to flood protection. There is an awareness that zoning has been practiced in other areas to

control development of vulnerable improvements in flood-prone locations, but lack of terrain conducive to development elsewhere has necessitated utilization of the flood plains. Flood proofing, emergency protection, and temporary evacuation are practiced less than in other regions because of the extreme heights to which flooding may occur and the lack of warning that normally is available.

The local feeling is that "Tug Fork must have flood control to grow; or even to continue to exist." Their requests for study and desires for projects have been directed toward reservoir projects upstream from the Williamson-Matewan area (particularly on Knox Creek) and for local protection of communities such as Matewan and the lower reaches of tributary streams such as Pond Creek. The local protection projects in which they are interested would involve levees, flood walls, channel improvement, snagging and clearing, and combinations thereof.

33. PROCEDURES FOR PLAN IMPLEMENTATION

If authorized, the Corps of Engineers would assume overall responsibility for coordinating and implementing the plan. For purposes of implementation, the plan can be divided into three basic parts as follows:

a. Land acquisition for the entire plan.
b. Construction of the dam and reservoir.
c. Operation and maintenance of the constructed works.

The Corps of Engineers would acquire all lands necessary for the plan which are not now in public ownership. The Corps would construct the dam and reservoir, including the recreation sites. Operation of the dam and reservoir would be the responsibility of the Corps, while operation, maintenance and replacement of recreation facilities would be the responsibility of non-Federal interests unless the authorizing document specifically recognized the difficulty of obtaining the non-Federal participation, because of depressed local economic conditions and because of complications arising from location in one state with much of the beneficial effects accruing to another state, and therefore, specifically waived cost-sharing requirements.

SECTION IX - CONCLUSION

34. CONCLUSION

The management of the streamflow of Knox Creek to alleviate flood damages, to provide water for water quality control, to provide water-based recreation opportunities, and to provide the products of related land and water management is required to sustain and enhance the economic well being in Sub-region G. The plan of development on Knox Creek, as set forth in this chapter, has taken note of foreseeable water resource needs and has provided as many solutions to those needs as appear possible. However, the studies made for this report indicate that, when all alternatives are considered, the Lower Knox Creek Reservoir project is not economically feasible at this time. Inclusion of regional and national redevelopment and developmental benefits does not increase the benefit-cost ratio significantly, nor appreciably affect the indices of performance.

The development of Lower Knox Creek, if implemented, would consist of the construction of the multiple purpose reservoir and its operation and maintenance. The development is estimated to have a total construction cost of $49,200,000. This is equivalent to an annual value of $1,891,000 which includes costs for operation and maintenance. It is estimated that this investment would create an associated private investment of $872,000. Benefits for the objective of increasing national income would be approximately $1,109,000 annually and benefits that would have a regional employment impact are estimated at $620,000 annually.

If implemented, the plan of development as set forth would require the joint efforts of the Corps of Engineers and the Commonwealths of Kentucky and Virginia, with aid in the advanced planning stage from several Federal agencies such as the U.S. Fish and Wildlife Service and the Federal Water Pollution Control Administration.

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